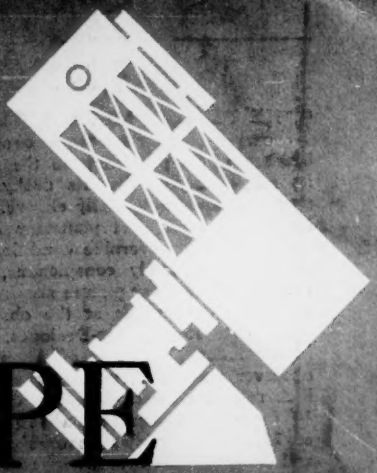
Sky and TELESCOPE



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Drawings of Mercury

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In Focus

THE PLANET MERCURY is not an easy object for telescopic observation, because of its proximity to the sun and its small size, so that its dusky surface markings are traditionally elusive. Nevertheless, to an expert planetary observer working under favorable conditions these markings are fairly conspicuous, as this month's front-cover picture shows. These drawings were made at the observatory of the late René Jarry-Desloges, at Sétif in the Atlas Mountains of Algeria. The observer was P. Briault, who used a 15-inch refractor, normally stopped down to 10 inches, with usually a magnification of 225. These views cover six months, and demonstrate the slowness of Mercury's rotation. According to Schiaparelli, Jarry-Desloges, and Antoniadi, Mercury rotates on its axis once in 88 days, the same time required for one orbital revolution. Thus, if both rotation and orbital motion were at constant rates, Mercury would always turn the same face to the sun, and therefore the surface markings would remain fixed relative to the terminator. Actually, Mercury's orbital motion is not uniform, so that the markings appear to shift slightly with respect to the terminator.

The features visible on Mercury when it is in the evening sky are well shown on the second drawing from the left in the top row. Here the dark bar near the bottom is **Solitudo Aphrodites**, directly above which is the bright region **Pentas.** The upper boundary of this is the dark marking **Solitudo Criophori.** The bright semicircular marking in the upper right is **Pieria.**

The middle drawing of Mercury in the second row illustrates its aspect in the morning sky. Near the center of the disk are two long dark streaks, **Horarum vallis** above and **Admeti vallis** below. The latter is seldom seen so distinctly as is shown here. The junction of these two streaks forms **Solitudo Lycaonis.** The names of the surface markings used here are those introduced by Antoniadi.

The drawings of Mercury at Sétif, of which the cover shows only a small sample, are among the best ever made of this planet. And, in turn, observations of Mercury are only a small part of the valuable contributions to planetary astronomy made by Jarry-Desloges. His death in 1951, when he was 83, closed a career unique among amateur astronomers. While there have been other amateurs who have devoted over four decades to the study of planetary surfaces, there are few who have operated three observatories simultaneously, or who have published 10 volumes of drawings and discussion of professional quality.

Jarry-Desloges erected his first observatory at Mont Revard in southern France to observe the favorable 1907 opposition of Mars with a 15-inch refractor. Eager to secure the best seeing conditions, he traveled widely with a 6-inch refractor for site testing. Subsequently, he organized three observatories for observing on a uniform plan the 1909 opposition of Mars. In this way cross-checking of results was possible. These three observatories were at Revard, Massegros, and Toury in France. The third of these stations was soon moved to Sétif in Algeria, where a 20-inch refractor was installed.

Such widespread activity was made possible by the enlistment of three able planetary observers, G. and V. Fournier and P. Briault. Their enthusiasm is illustrated by G. Fournier who, during his service in the French army in World War I, continued his work with a 6-inch refractor at Reims within range of German artillery. With this telescope Fournier could observe Martian surface features by night, and see the enemy trenches by day.

The principal object of study by this chain of observatories was Mars. Not only were many drawings made, but extended investigations were carried out on phenomena of the polar caps and the Martian atmosphere, on changes in the dark markings, and on the visibility of the canals. The value of this work is enhanced by the fact that it was not precommitted to a particular theory of the nature of the Martian surface features. In addition to these Martian studies, numerous drawings of the other planets and the moon were made.

The 10 volumes of **Observatoires Jarry-Desloges: Observations des Surfaces Planetaires** which contain these results must be classed among the greatest contributions which an amateur has made to astronomy. Perhaps his opportunity no longer exists, for the scope of planetary observation has been greatly broadened in recent decades by the application of astrophysical techniques. The professional astronomer, armed with spectrograph, photoelectric photometer, and polarimeter, is now paying increasing attention to the planets.

One of these newer methods which promises to be more and more important is planetary photography in light of different colors, which is illustrated by this month's back cover. The two photographs of Jupiter were taken with the 200-inch Hale reflector at Mount Palomar. The upper picture, photographed in red light,

(Continued on page 320)

Sky and TELESCOPE

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The Transit of Mercury - November 14, 1953

By Fletcher G. Watson, *Harvard University*

On November 14, 1953, you may observe a fairly rare astronomical event when the planet Mercury passes between the earth and the sun, appearing as a tiny black dot against the sun's bright surface. While such transits occur on the average 13 times per century, few are so conveniently visible throughout the Western Hemisphere as this one.

Because Mercury is so small, only 3,000 miles in diameter, it is not easily seen against the sun. During the transit, it will have an apparent diameter of only 10 seconds of arc, about the size of a penny a quarter of a mile away. To see Mercury distinctly when it is in front of the sun, a magnifying power of at least 100 should be used. Of course, the blinding brilliance of the sun should not be viewed directly through a telescope. Instead, project an image of the sun upon a piece of white cardboard which can be watched without harm to your eyes.

The progress of Mercury across the sun during the transit is conveniently summarized by contacts, equivalent to the four contacts of a total solar or lunar eclipse. Contact I is when Mercury first touches the edge of the sun; at contact II all of the planet first shows against the solar disk; at III Mercury first reaches the other limb of the sun; and at IV it has completely passed off. For an observer at the center of the earth, or having the sun exactly in his zenith, the predicted times of these events are, according to the *American Ephemeris*:

I	$15^h\ 37^m\ 04.4^s$ UT
II	15 40 41.1
III	18 07 11.3
IV	18 10 48.0

These predictions, given above in Universal time, can be changed to Eastern standard time by subtracting five hours; to Central standard time by subtracting six hours, and so on.

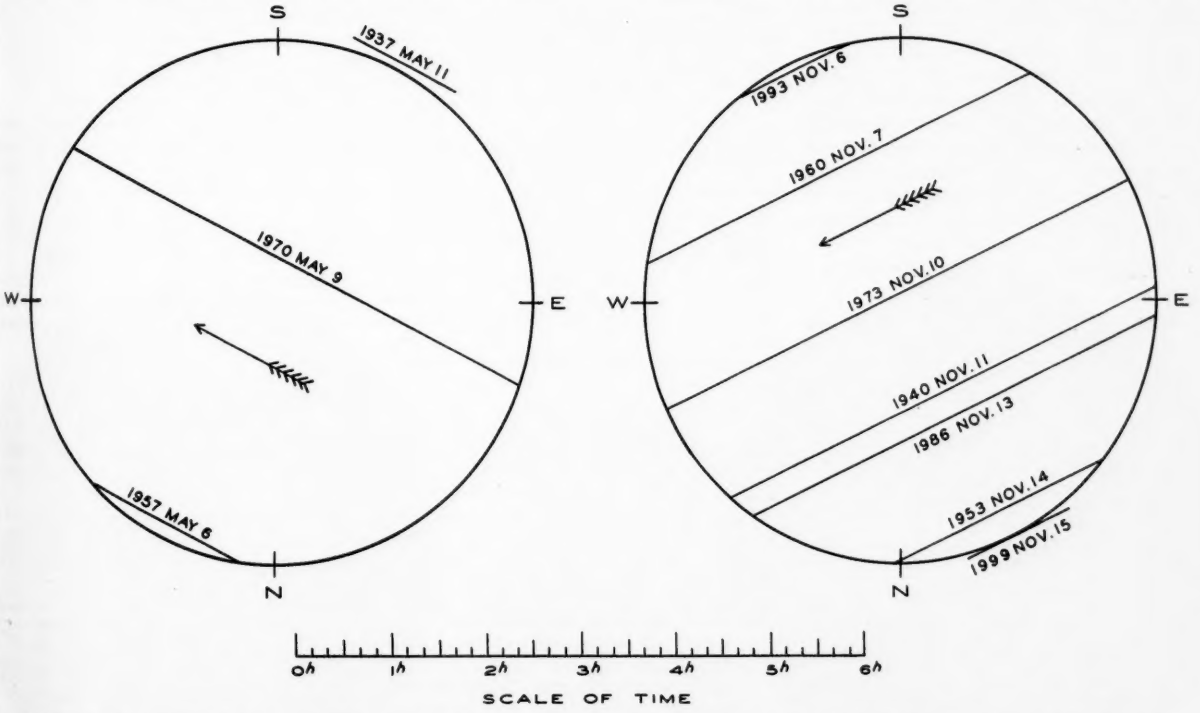
Because no one in the Northern Hemisphere could have the sun in his zenith during November, the actual times you will observe for these contacts will differ from the predicted ones by some seconds. If you are located so that the sun is near the horizon, the contact times can differ as much as two minutes from those given above.

As indicated in the diagram, Mercury first shows at a point about 50 degrees east of the north-south line through the sun's center. It leaves the sun, however, only some four degrees west of the north point. As the figure shows, Mercury's track will remain near the limb of the sun. To orient the sun's image, let it drift across the field of your telescope — the forward edge will be west.

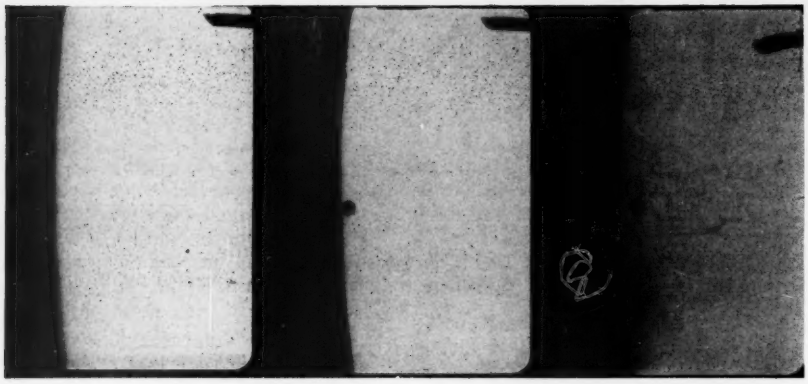
Of the 13 or so transits of Mercury across the sun per century, all occur within a few days of May 8th and November 10th. On these dates Mercury passes through the plane of the earth's orbit, and we may see it in line with the sun. At any other time of the year when Mercury passes the sun, it goes above or below the latter, since Mercury's orbit is tilted seven degrees to the earth's orbital plane.

At the transits in May, Mercury is nearly at its maximum distance from the sun, and the probability of a transit taking place is lessened. In November Mercury is nearer the sun, and consequently November transits are nearly twice as numerous as May transits. November transits may recur at intervals of seven, 13, or 46 years; the latter two intervals are more common than that of only seven years. For transits in May the seven-year interval is impossible, but the 13- and 46-year spacings apply. The latest transit of Mercury was on November 11, 1940.

Observations of transits of Mercury might seem prosaic and of little interest. Yet these have been involved in a great



Tracks of Mercury across the sun at May and November transits from 1937 to 1999. The duration of each transit can be found by comparison with the time scale underneath. On May 11, 1937, Mercury just missed the southern limb of the sun, but was observed by Lyot in silhouette against the corona. The grazing transit of November 15, 1999, may be the first observed case of a partial transit of Mercury. Adapted from the "Astronomical Papers of the American Ephemeris."



These Mount Wilson photographs of the 1940 transit show how small Mercury appears as it encroaches on the sun's disk.

astronomical mystery and an even greater discovery. From the observed times of the transits, it is possible to find the orbit of the planet with high accuracy. Due to the pull of other planets, especially Venus, upon Mercury, the elongated orbit of the latter gradually turns around. As early as 1859 the great French mathematical astronomer Leverrier found, from a study of earlier transits dating back to 1677, that Mercury's orbit rotated 574 seconds of arc per century while the predicted amount was 43 seconds less.

This discrepancy was far too large to be explained away as observational error. Many ingenious proposals were made to account for the difference. These included: intramercurial planets, nonsphericity of the sun, error in the adopted mass of Venus, diffuse interplanetary matter, and departure of the law of gravitational attraction from the reciprocal square of the distance. In 1895, Simon Newcomb discussed critically all these alternatives and proved that all were either incapable of accounting for the rapid rotation of Mercury's orbit, or led to disagreement with other planetary motions which *were* accurately described by existing theory.

Finally, the general theory of relativity, advanced by Einstein in 1916, resolved the mystery. In this theory Einstein proposed that the mass of a body depended on how fast it was moving. If the body was "at rest" relative to the comparison body, it had a certain "rest mass" M_0. But when the body moved with a velocity v, the effective mass M was increased to $M=M_0\ (1-v^2/c^2)^{-\frac{1}{2}}$, where c is the velocity of light. Within the solar system most of the planets move like Venus in nearly circular orbits. But Mercury has an eccentric orbit which causes its velocity to change from 24 miles per second when farthest from the sun to 37 miles per second when nearest the sun. This small difference turned out, according to the theory of relativity, to change the effective mass of Mercury just enough to account for the observed rate of orbital rotation. In fact, this advance of the perihelion of Mercury's orbit was the first and possibly is the strongest observational check upon the theory of relativity.

When you observe the transit, perhaps you will recall that even the simplest observations may lead to complex problems and these in turn to deeper understanding of how the universe operates.

PAST AND COMING TRANSITS OF MERCURY

This table, adapted from the **Astronomical Papers of the American Ephemeris,** can be extended to later or earlier centuries by adding or subtracting 217 years (more precisely, 79,260 days) for each date listed.

1891 May 9	2003 May 7
1894 Nov. 10	2006 Nov. 8
1907 Nov. 14	2016 May 9
1914 Nov. 7	2019 Nov. 11
1924 May 7	2032 Nov. 13
1927 Nov. 10	2039 Nov. 7
*1937 May 11	2049 May 7
1940 Nov. 11	2052 Nov. 9
1953 Nov. 14	2062 May 10
1957 May 6	2065 Nov. 11
1960 Nov. 7	2078 Nov. 14
1970 May 9	2085 Nov. 7
1973 Nov. 10	2095 May 8
1986 Nov. 13	2098 Nov. 10
1993 Nov. 6	2108 May 12
1999 Nov. 15	2111 Nov. 14

*Very close approach of Mercury to sun's southern limb.

TIMING THE TRANSIT OF MERCURY

MERCURY'S passage across the sun's disk on November 14th offers amateur astronomers an opportunity to make observations of permanent scientific value. The data desired are accurately observed times of the phenomenon, and these can be obtained by anyone who has the instrumental equipment for observing sunspots, and who has had experience in timing occultations.

At present the scientific interest in transits of Mercury centers on the information they give on the irregularities in the earth's rotation. The importance of this problem is evident from the fact that the rotation period of the earth on its axis is the standard of astronomical time. For several decades the earth has been rotating at slower than its average rate, so that the accumulated error since 1900 is now about 30 seconds of time. Rapidly moving bodies in our solar system, such as the moon and Mercury, can be used as independent timekeepers to check the rate of the earth's rotation. The most suitable Mercury observations for this purpose are times of contact with the sun at transits.

For the transit of November 11, 1940, the U. S. Naval Observatory organized a world-wide campaign to recruit observers, and distributed detailed instructions. The result was the co-operation of 190 observers, of whom 80 per cent were amateurs. G. M. Clemence, director of the Nautical Almanac Office, states that while no campaign has been planned for the 1953 transit, careful observations of contact times are very desirable, and these should be put on permanent record for possible future use.

Consequently, **Sky and Telescope** will collect and publish reliable observations of the coming transit, made in accordance with the following directions. The instructions are based on those circulated by the U. S. Naval Observatory in 1940, published in The SKY for September of that year.

Instruments. Refractors used should be of at least 3-inch aperture, and reflectors at least 5-inch. A magnifying power of 100 to 200 is recommended. Solar observing is a specialized activity, and great care should be employed to avoid damage to one's eyes. A Herschelian eyepiece is recommended, or projection of the sun's image on a screen or cardboard. Dark glasses and filters often prove inadequate or may shatter under the intense heat (carelessness or an accident may mean blindness). If an observer does not do regular solar work, he should read such instructions as those published by the Solar Division of the AAVSO, and discussed by D. W. Rosebrugh in this magazine in May, 1951. He should spend considerable time on practice and experiment **before** the day of the transit.

Phenomenon. There are four instants when the disks of Mercury and the sun are tangent to each other. The instants of external tangency are contacts I and IV; the instants of internal tangency are contacts II and III. Since contacts I and IV cannot be timed accurately, observers should concentrate on II and III.

The sequence of events on November 14th is: At contact I (about 15:37 Universal time) Mercury begins to enter on the sun's disk. Its apparent diameter will appear about 1/200 that of the sun. Some three minutes later a phenomenon will occur that can be mistaken for contact II, for Mercury appears internally tangent to the sun. But light is not visible all around the planet yet, and this is **not** the time of contact II. About this time the so-called black drop begins to form, and some 20 seconds later Mercury will look like a black drop attached to the sun's limb. When the black drop breaks away from the

(Continued on page 317)

WHAT HAPPENS TO STAR CLUSTERS?

By Otto Struve, *Leuschner Observatory, University of California*

With the information on the densities of open or galactic clusters discussed in last month's article, we can estimate the stability of these and similar objects and seek to describe their past histories and future development.

The method used by theoretical astronomers to estimate the stability of a cluster is one we associate with the name of Roche. He used it originally to determine the effects of tidal stresses of a planet on its satellites, and found that a liquid satellite would be disrupted by such tidal action if its distance from the center of the planet were less than about 2½ times the radius of the planet. For example, a compact satellite could not exist in the region in which we now observe the rings of Saturn; if there ever was such a satellite, it was disrupted into many small particles which retain their identity by the forces of cohesion that exceed the gravitational forces when the solid particles are small.

If the internal gravitation of the parts of a star cluster exceeds the tidal disrupting action by the Milky Way galaxy, the cluster is stable, and if the stability factor is great, we may then assume that such a cluster can retain its identity without serious disturbance for many billions of years. If, however, the disrupting action of the Milky Way is greater than the internal gravitation, the cluster is no longer stable and will be disrupted within a relatively short time. When the two quantities are identical, the cluster is on the verge of instability.

As explained by Bart J. Bok in his article referred to last month (*Sky and Telescope,* July and August, 1951), we find that for a cluster to be stable the density must be greater than a specific value. This quantity is obtained when we multiply the mass of the galaxy by 10 and divide it by the cube of the distance between the center of the galaxy and the center of the cluster.

Let us consider the Pleiades, listed in the table on page 294 last month. Near the center of this cluster there are about three stars per cubic parsec. Since the Pleiades form a part of the Milky Way, we estimate that the attraction from the inner portions of the galaxy is equivalent to that of about 10^{10} solar masses. The distance between the Pleiades and the galactic center is of the order of 10,000 parsecs, the cube of which is 10^{12}. The ratio of 10 times the attracting mass to this cube is therefore $10^{11}/10^{12}$, or 0.1 star per cubic parsec. Thus the central regions of the Pleiades would be reasonably stable, even though the stability factor is not particularly large and in time intervals of the order of a few billion years the perturbations by the Milky Way might be expected to modify greatly the shape of this cluster.

In the case of the Hyades, where the observed star density is only of the order of 0.25 per cubic parsec, the situation is definitely more critical, and this cluster is on the verge of instability. All those clusters and associations that have star densities less than one star per 10 cubic parsecs are unstable and must be disrupted rapidly by the tidal forces of the galaxy.

How, then, does this disruption proceed? For a reasonably compact cluster, like the Pleiades or even the Hyades, the theory is complicated. The lifetime of such a group must be computed by a statistical method of estimating the cumulative effect of perturbations from neighboring stars. The most complete work of this nature has been done by S. Chandrasekhar. He has computed the fraction of the stars that are lost, or we might say evaporated, from a cluster during an interval Δt, and has found it approximately equal to $0.0074\,\Delta t$ divided by the time of relaxation of the cluster. For any given group of stars the relaxation time is the period required for a random distribution of motions to be reestablished after it has once been disrupted. This time for a typical open cluster is about 30 million years.

We can compute, for instance, the time in years (Δt) during which one half of the original members of the cluster will have been evaporated. The computation is $\frac{1}{2} \times 3 \times 10^7/0.0074$. This is approximately two billion or 2×10^9 years.

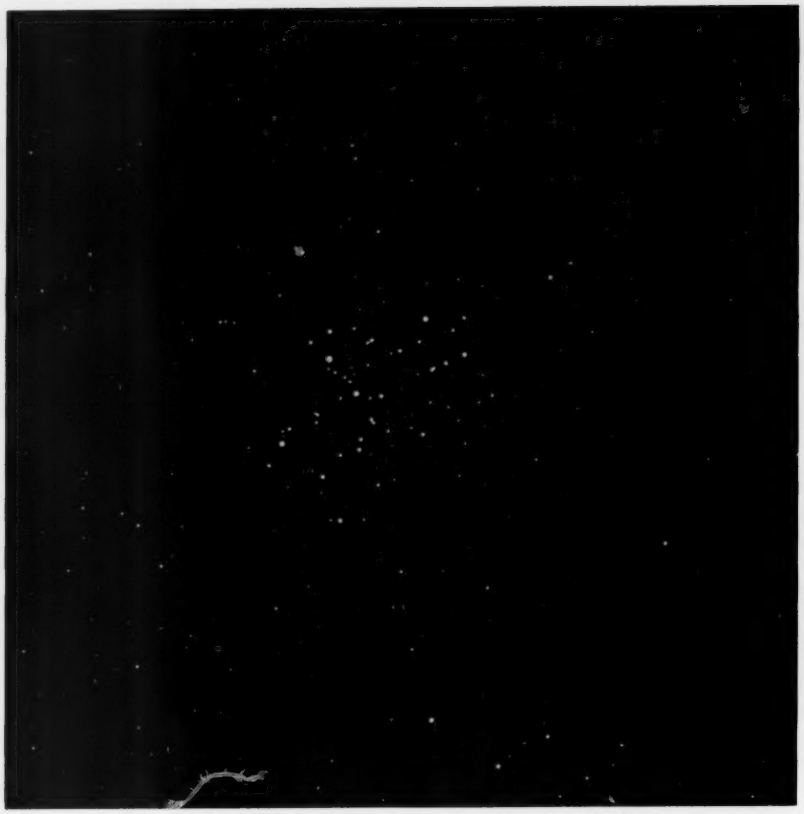
Although the more stable clusters will be disrupted in slightly longer periods and the less stable ones will disappear in less than a billion years, the average value derived by Chandrasekhar is consistent with the idea that such a cluster can retain its identity for only a fraction of the age of the galaxy as a whole. This is an excellent confirmation of our hypothesis that the open clusters which we now observe are all relatively young formations, and those clusters that may have originated three billion years ago have long since been dispersed among the broad features of our galaxy's spiral structure.

In the case of the loose stellar associations, the tidal action of the Milky Way proceeds even more rapidly in its work of destruction. Ambarzumian has shown that those regions of a stellar association that are nearest to the center of the galaxy revolve more rapidly in the galaxy's rotation than do those regions that are farthest away. This is a consequence of the third law of Kepler, which, when applied to this case, predicts that the orbital period of a star in the galaxy is proportional to the 3/2 power of the distance from the galactic center. The result is a tendency of the

Left: The open cluster NGC 663 in Cassiopeia, which has an apparent diameter of 14 minutes of arc and is of type IV 2m, according to R. Trumpler.

Right: The open cluster NGC 7160 in Cepheus, 10 minutes of arc in apparent diameter and of type I 3p.

Reproduced from Markaryan's atlas of galactic star clusters.



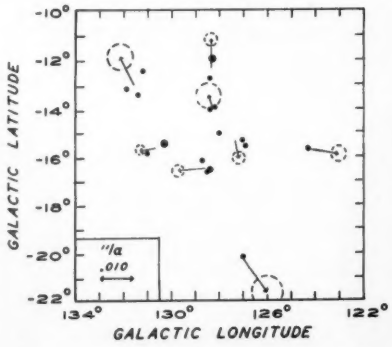
This photograph of the cluster NGC 6405, M6, in Scorpius, like those on the preceding page, is an enlargement from plates taken with the 8-12-inch Schmidt camera at the Burakan Observatory. From Markaryan's atlas of clusters.

cluster to be spread out within the plane of the Milky Way; it can be shown that by this effect a stellar association will double its length in approximately 30 million years.

However, the observational fact, first noticed by Ambarzumian, that nearly all known associations are roughly spherical in shape and do not show any tendency to be elongated in the plane of the Milky Way, led him a few years ago to conclude that such associations are much younger than 30 million years. Evidently, there has not been enough time for them to be spread out in the plane of the Milky Way. Furthermore, the fact that the associations are observed as spherical suggested that each is rapidly expanding with a uniform velocity in all directions. This would mask the tendency toward elongation due to the shearing effect by the Milky Way. Ambarzumian suggested that this hypothetical expansion should be of the order of five kilometers per second, an average star within a given association moving away from the center of the group with that velocity.

This conclusion was recently confirmed in a most dramatic way by A. Blaauw at Leiden. From a study of the proper motions and radial velocities of the stars in an association centered around the famous *B*-type star Zeta Persei, he established that this group expands with an average speed of about 12 kilometers per second.

Roughly speaking, the area in the sky occupied by this association has a diameter of six degrees. Its distance, found from the Hertzsprung-Russell diagram, is about 1,000 light-years. Hence, in kilometers, the radius of this association is about 5×10^{14}. If a star at the edge of this system is now moving outward by 12 kilometers in one second, it would have been near the center of the association $5 \times 10^{14}/12$ or about 5×10^{13} seconds ago. This is roughly one million years. Hence, Blaauw concluded that the age of this group is of the order of one million years.



The expansion of the Zeta Persei association is shown by the arrows representing relative proper motions, to a scale of 0.010 second of arc per annum. The diagram is adapted from the "Bulletin" of the Astronomical Institutes of the Netherlands.

Blaauw and his associates at Leiden, including J. H. Oort, firmly believe that the observational data on which this conclusion is based are unassailable. The best argument is Blaauw's final diagram of the motions in the Zeta Persei association, from which the accompanying illustration has been adapted. This shows the proper motions of all *O* to B_5 stars of the group, the arrows representing the relative proper motions for individual stars or weighted means for subgroups of two or three stars close together on the sky. The tails of the arrows are in the centers of these groups. The radii of the dashed circles represent the probable errors of the proper motions. Stars brighter than visual absolute magnitude −4 are represented by large dots. Blaauw says, "The directions of the arrows show clearly the expansion of the group, especially if we consider the stars at the greatest angular distance from its centre."

It should be remembered that the arrows have been derived from a large number of observations. It is difficult to find serious fault with the conclusions despite the fact that the scattering of the arrows is fairly large, due no doubt to unavoidable errors of measurement.

The manner in which the Milky Way proceeds with the destruction of an expanding association of relatively greater age than the Zeta Persei association has also been demonstrated by Blaauw, in a paper appearing in the same number (433, June 20, 1952) of the *Bulletin* of the Astronomical Institutes of the Netherlands. In this he shows that the tidal or shearing effect of differential galactic rotation causes the association to become elongated in a direction that changes with time, finally oscillating around a line at right angles to the direction from the center of the association to the center of the galaxy.

Blaauw's computations are well illustrated in the diagram on page 315. He finds for the specific case of the famous Scorpius-Centaurus group of *B*-type stars that the orientation of the elliptical configuration corresponds to an expansion age of about 72 million years, with original velocities of expansion for the outermost stars of one kilometer per second. This age seems to fit the observed brightnesses of these stars and the fact that there are no very young stars (earlier than type *B*0) in the group.

Since the publication of Blaauw's papers last year several other associations have been investigated, for example, one by Soviet astronomers and one more recently by Morgan and Blaauw at Yerkes Observatory. They all seem to confirm the existence of the expansions, and the

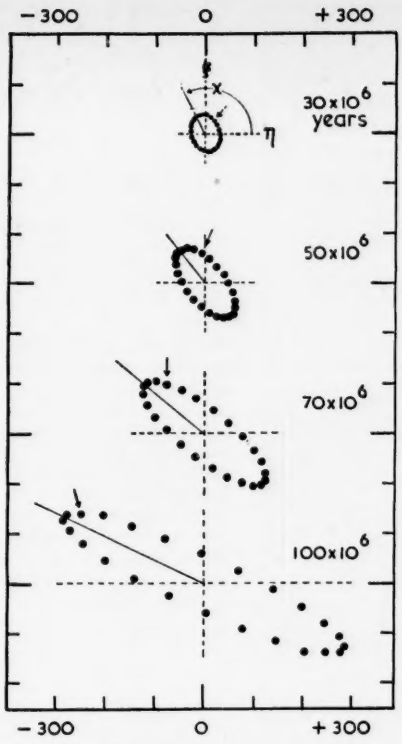
resulting ages turn out to be in the vicinity of 10 million years.

We are still completely in the dark as to the origin of these expansions. At one time Ambarzumian had apparently been thinking of some catastrophic explosion in a prestellar body of hundreds or even thousands of solar masses and of a kind not previously recognized in astronomy. At the Rome meeting of the International Astronomical Union, he no longer stressed this hypothesis; it is perhaps best to retain an open mind as to the origin of the motions. It is reasonable to believe that expansion rather than contraction is a characteristic property of all formations of the universe, and perhaps we must not be surprised that such a phenomenon occurs in associations as it does in expanding stars or in the system of expanding galaxies. At the same time we should guard against any attempt to relate these outward motions to processes requiring the use of relativity theory; the chances are that they can be explained in terms of ordinary Newtonian dynamics.

We now turn to the problem of the globular clusters. These remarkable accumulations of virtually countless individual stars often contain a number of pulsating variables of the RR-Lyrae type. These stars have periods of less than one day and absolute magnitudes equal to zero. They are thus about 100 times more luminous, intrinsically, than the sun. When we locate such a variable in a globular cluster and measure its apparent magnitude, the latter is equal to the distance modulus of the cluster, and from this we can derive the distance in parsecs. With cameras of short focal length, we can next compare the total light of a globular cluster with the apparent magnitudes of neighboring stars and, knowing the distance, convert this integrated apparent magnitude into the corresponding integrated absolute magnitude.

The integrated absolute magnitude of an average globular cluster is about −8. The absolute magnitude of the sun, as it would appear at the standard distance of 10 parsecs, is +5. Such a cluster is therefore intrinsically 13 magnitudes brighter than the sun, and this can be interpreted to mean that the average cluster, if it were made up of stars of the sun's luminosity, would contain 2.5^{13} or about 10^5 stars. We thus find, without making any star counts, that a typical globular cluster consists of about 100,000 individual stars.

Complete star counts are not possible in globular clusters because near the centers of these objects the star images overlap to such an extent that we cannot count them. In the outer regions, however, where the star images do not interfere with each other, H. Shapley and F. G. Pease counted 5,000 stars in the southern cluster Omega Centauri and 70,000 stars in M22 in Sagittarius.



Blaauw's diagram here shows how the shape of a stellar association increases with age. The direction toward the galactic center is downward, and the distances are expressed in parsecs. For associations younger than 30 million years, a velocity of expansion of one kilometer per second will mask the elongation due to galactic rotation. Associations older than 100 million years are far advanced toward dissolution. The present shape of the Scorpius-Centaurus group closely matches the third figure from the top. From the "Bulletin" of the Astronomical Institutes of the Netherlands.

The average star density of a globular cluster having a radius of 40 parsecs, found from the ratio of the total mass and the volume, is about 0.4 star per cubic parsec, but near the center the density could easily be 100 or even 1,000 times greater. The criterion of stability, 10 times the mass of the galaxy divided by the cube of the distance between the cluster and the galactic center, is in this case, at most, about one star per cubic parsec. Clearly, the globular clusters are completely stable formations, and the degree of stability is so large near the centers of these objects that they can undoubtedly retain their identities indefinitely.

Unquestionably, this is the reason the color-magnitude diagrams of the globular clusters have been found to correspond to ages of the order of five billion years, differing fundamentally from the diagrams constructed for the open galactic clusters.

The formula for the critical density of a cluster with respect to its stability also appears to have great significance in the actual formation of individual stars. V. G. Fessenkov has stressed the idea that stars appear to form within a large system, such as a galaxy or a condensed cloud of dust and gas, when the density is at least as large as the ratio of 10 times the disturbing mass to the cube of the distance between that mass and the newly forming star.

For example, in the spiral arm of which the sun is a member, Fessenkov adopts a disturbing mass approximately 10^{11} times the mass of the sun, or about 2×10^{44} grams. He uses for the distance to the galactic center 8,000 parsecs or 2.4×10^{22} centimeters. The resulting critical density is approximately 10^{-22} grams per cubic centimeter. This is about 100 times greater than the average density of the interstellar gas as observed at the present time. But even now there are concentrations of gas, for example in the region of the Orion nebula, where the density is of the order of 10^{-22} and even more. We must suppose that stars are now being formed in the region of the Orion nebula, and perhaps the Orion association of *O* and *B* stars (long ago described as the Orion type of stars) represents the very process of star formation that is going on at the present time.

No doubt we shall find that an important stage of star formation is indicated by the presence in the Orion nebula of hundreds of emission-line variables resembling the star T Tauri. As G. Haro in Mexico has shown, these stars are not only numerous but they are variable in light as well as in spectrum. His work and that of G. Herbig at the Lick Observatory, though not yet completed, strongly suggest that they are newly formed stars that are still growing as the interstellar grains and atoms gradually increase their masses.

Fessenkov has pointed out that for an average density of a nebula equal to 10^{-22} grams per cubic centimeter the volume of space that in the diffuse state contains one solar mass, or 2×10^{33} grams, corresponds to a radius of about 10^{18} centimeters or 100,000 astronomical units. The sun is 270,000 astronomical units from its nearest stellar neighbor, and other distances in our part of the Milky Way are similar. Here we have another argument in favor of the hypothesis that the stars have been condensed from a medium equal in density to the critical value: The average distances between neighboring stars are just about what would be required to produce the critical density if their masses were spread uniformly through the galaxy.

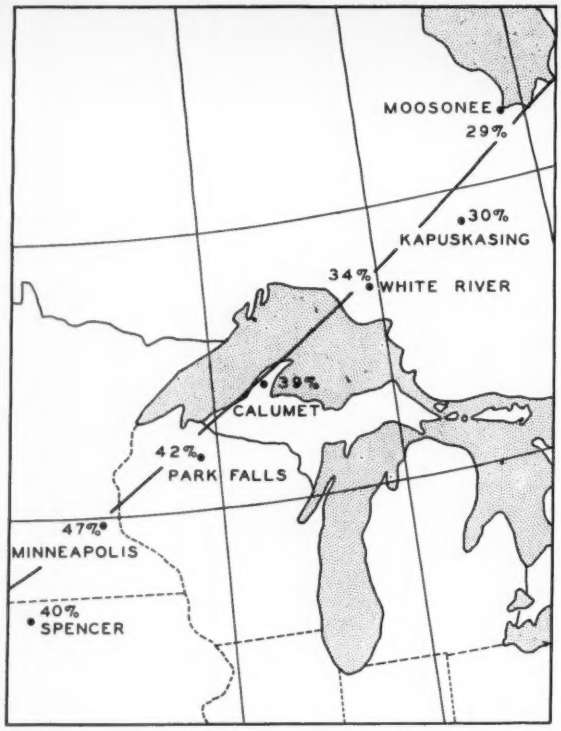
CORRECTION

On page 234, **Sky and Telescope**, July, 1953, the date of the picture showing the telescopic appearance of Greenland should be July 18, 1820, instead of 1920.

The Weather Outlook for Next Year's Eclipse*

By Edward M. Brooks

Institute of Technology, St. Louis University



The author has investigated the weather probabilities for June and July mornings at the seven weather stations shown on this map. The percentages indicate the probabilities that the total eclipse will be visible. The central line of the eclipse is indicated; the path of totality is about 75 miles wide.

NO METEOROLOGIST can give a reliable forecast of the weather for the eclipse on June 30, 1954, until a few days before that date. But astronomers will not wait for this forecast, as they are already selecting their observation points, and planning to set up their equipment weeks before the eclipse. Consequently, for weather information, they must rely on the records of past weather along the eclipse path. The purpose of this paper is to compare the chances of observing the eclipse at different places in the United States and Canada, along the most accessible portions of the path of totality.

A first estimate of sky conditions might be based on the average cloudiness for June and July (a month either side of the eclipse date) already available in published climatological summaries. Both June and July average cloudiness maps (from Sir Napier Shaw's *Manual of Meteorology*, Vol. II, pages 158, 160) show values increasing northeastward from less than 0.5 cloudiness at the beginning of the eclipse path in northeastern Nebraska to more than 0.7 cloudiness on the Labrador coast.

This is useful information, but is not sufficiently refined, for the averages are for the entire day rather than for 5 a.m. CST, the approximate time of the total eclipse, and there is no differentiation between clouds of different thicknesses. The necessary refinements were made by tabulating weather reports from daily weather maps for 6:30 a.m. CST on five June's (1949-1953) and six July's (1948-1953). The four weather stations in the United States and the three in Canada within or near the eclipse path that were selected for the tabulation are Spencer, Iowa; Minneapolis, Minn.; Park Falls, Wis.; Calumet, Mich.; White River, Ont.; Kapuskasing, Ont.; and Moosonee, Ont.

For each day's 6:30 a.m. observation, a decision was made as to whether or not an eclipse could have been seen if it had occurred. This decision was based on cloudiness, visibility, and precipitation. It was assumed that the eclipse could be seen through clouds only if they were thin and not continuous, which is usually the case for high clouds, but not for middle or low clouds. The cloudiness criteria for success were that high clouds did not cover the whole sky, middle clouds did not cover more than 3/10 of the sky, and low clouds did not cover more than 1/10 of the sky. If the 6:30 a.m. report said that the cloudiness was increasing, more tolerance in these criteria was allowed, and if the cloudiness was reported as decreasing, less tolerance was allowed, because the observation was 1½ hours after the time of the hypothetical eclipse. Visibility was considered important because of the low altitude of the sun above the horizon at 5 a.m. Successful observing was assumed only if there was no haze at 6:30 a.m. and if within the previous six hours due to radiational cooling there had been no fog. Also, observing was called successful only if no rain or thunder had occurred during the previous four hours (2:30-6:30 a.m.).

The accompanying figure shows the results, which generally confirm the increase of average cloudiness, or decrease of visibility, toward the northeast along the eclipse path. Minneapolis, with 47 per cent successful observing, proved best, having 156 acceptable days, or nearly half of the 334 days tabulated. Park Falls, in second place with 42 per cent seeing, was better than Spencer, in third place with 40 per cent. The conditions deteriorated progressively to the James Bay region, where Moosonee, with 29 per cent, had only 92 good days, or slightly more than one quarter of 319 days.

The criteria of the analysis for visual observations of the eclipse are not restrictive enough for instrumental observations. For astronomical photography, a new set of necessary conditions was chosen. The sky should be completely clear, the relative humidity should be as low as possible, and the sun and moon should have an altitude of more than five degrees above the horizon. A tabulation of the number of mornings without clouds, fog, or haze gave the results listed in the last column of the table. Park Falls had 78 perfect days, or nearly one quarter of 320 days. Minneapolis, with only 12 per cent, had only half as many perfect days, 41 of 334. Minneapolis and Spencer are judged unsuitable, however, because of the low solar altitudes of about 5° and 3°, respectively, at eclipse time.

As no observation points other than Park Falls and Spencer had over 15 per cent perfect days, the odds appear poor for observations from Michigan north-

Weather Station	*Elevation in feet*	*Altitude of sun and moon*	*Average relative humidity*	*Chance that eclipse will be visible*	*Chance for no clouds, fog, or haze*
Spencer, Iowa	1,339	3°	86%	40%	18%
Minneapolis, Minn.	838	5°	81%	47%	12%
Park Falls, Wis.	1,539	7°	82%	42%	24%
Calumet, Mich.	1,240	9°	83%	39%	15%
White River, Ont.	1,243	12°	88%	34%	14%
Kapuskasing, Ont.	752	14°	86%	30%	10%
Moosonee, Ont.	34	16°	80%	29%	9%

*Presented at the general convention of the Astronomical League in Washington, D.C., September, 1953.

eastward, where the higher altitudes of the sun and moon may be useless because the sun is so often hidden behind clouds. Park Falls is also favored by an average relative humidity at 6:30 a.m. in June and July of 82 per cent, which is slightly lower than at some of the other stations. The effect of Lake Superior on the relative humidity on summer mornings is slight because at that time the temperature of the water is nearly the same as the temperature of the surrounding land.

In conclusion, Minneapolis looks best for visual observations because the sky is less often overcast and the air is relatively dry. On an average morning, the eclipse should be visible through scattered clouds. On the other hand, Park Falls may offer the best opportunity for work with astronomical instruments, because whenever the sky clears, it is likely to clear up completely in the dry air of high-pressure areas between storms.

These suggestions based on climatological statistics are offered to help observers take into account weather conditions. At best, it will be a gamble to find the right spot to see and observe the eclipse because none of the chances for success runs over 50 per cent. Perhaps the answer is to fly an airplane above any low clouds that may be present.

My personal plan is to locate in the northeastern part of St. Paul to get a view of the sun and moon away from the city smoke of St. Paul and Minneapolis to the west. If a storm center is moving into the Dakotas on eclipse day, a last-minute shift of location to Wisconsin will be made.

TIMING THE TRANSIT OF MERCURY

(Continued from page 312)

limb is the time of true contact II. At this instant a thread of light first becomes visible between the planet and the sun's edge. Because of poor seeing, this time may be uncertain by some 10 seconds; in this case, record the beginning and end of this interval of uncertainty.

Well over two hours later, a similar sequence of events takes place in reverse order as Mercury moves off the sun's disk. The time to record for contact III is the instant of the breaking of the thread of light between Mercury and the sun's limb.

Correct time. The observer should have a source of correct time accurate to a second or two. If a pendulum clock with a second hand is not available, a first-class pocket watch can serve. **Synchronous electric clocks should not be used.** The clock or watch should be compared with accurate radio time signals on several days before and after the transit. No attempt should be made to correct the timepiece, but a record should be kept of its error from day to day. If a watch is used, it should be kept stationary in the same position for several days before and after the transit, and should be wound at the same time each day. In general, the observer can safely follow the same precautions in securing the correct time that he would follow in occultation work (see D. W. Rosebrugh, **Sky and Telescope,** January, 1952, page 71).

Timing the transit. The observations of the contact times should be to the nearest second. The most satisfactory plan is for the observer to have an assistant, who watches the timepiece and counts the seconds aloud, from the time of first contact until after second contact is past, and again at third contact. The observer listens to this count and notes the time of contact mentally. It is important to record any uncertainty in the observed time.

Geographical position. The latitude and longitude of the observer should be known to about one minute of arc. These can be found conveniently from maps of the U. S. Coast and Geodetic Survey or the U. S. Geological Survey. If the latitude and longitude are not known, the distance in miles and the direction from the center of the nearest city or town should be given.

Reporting your observation. Since only reliable observations free from ambiguity can be published by **Sky and Telescope,** observers are requested to send in detailed reports, and in particular to explain how the correct time was found. The information needed includes: 1, name, address, and geographical location of the observer; 2, size and magnification of the telescope used, or diameter of the solar image if this is projected on a screen; 3, description of the timepiece and record of its performance; 4, source of standard time; 5, standard times of observed contacts; 6, any circumstances such as poor seeing or clouds which could affect the quality of the observation. Your report should be mailed to Sky and Telescope, Harvard College Observatory, Cambridge 38, Mass.

ASTRONAUTS MEET IN SWITZERLAND

THE FOURTH annual congress of the International Astronautical Federation was held at Zurich, Switzerland, on August 2-8, 1953. Like the previous meetings in Paris (1950), London (1951), and Stuttgart (1952), this IAF reunion was intended to promote the idea of space flight, and to further international co-operation toward this goal. The purpose of the IAF is the exchange of technical information on astronautics, rather than directing the achievement of space flight itself. Furthermore, the IAF encourages the formation of new national and regional rocket societies, and tries to strengthen the existing ones.

The host at this year's meeting was the Swiss Astronautical Society. Delegates represented societies in Argentina, Austria, Denmark, Germany, Great Britain, Holland, Italy, Sweden, Switzerland, and the United States, while representatives came also from Egypt, Israel, Japan, and Spain. Other societies in South Africa, Yugoslavia, and the city of Philadelphia were admitted to the IAF for the first time.

Among the projects decided upon at the business meetings of the IAF were the compilation of an astronautical dictionary and the publication of an official organ, *Acta Astronautica.* The *Acta,* which will probably appear quarterly, will contain research papers presented at IAF meetings, and will give news of astronautical interest. It was further decided that the fifth congress will be held at Innsbruck, Austria, on August 2-7, 1954.

About 30 scientific papers were read, ranging in character from very technical to quite general. Dr. Irene Sänger-Bredt and Dr. Eugen Sänger (France), in separate papers, discussed atomic-powered and photon-beam-powered rockets. Rocket engineering was taken up by Rosen and Snodgrass (U.S.A.) and Casiraghi (Italy). Many papers by American, German, Dutch, and British contributors dealt with space-station construction, earth-scanning equipment for unmanned orbital vehicles, interplanetary communication from rocket to base, and with the mathematical aspects of interplanetary navigation.

A step-rocket scheme was outlined by Prof. General Crocco (Italy) which could place a one-ton payload into an orbit. He believed that this plan could be carried out by private industry at a fairly moderate cost, without government aid. In a second paper, he described a "parallel type" multi-stage missile design. In this more complicated plan, the payload rocket would be refueled in flight from tank missiles, attached to the rocket in parallel. The tankers, when empty, would be dropped off, and could be used many times, according to Crocco.

Possibly the most significant address was that by Wernher von Braun, who now works in the U. S. Army's guided missile program. He believes that space flight is possible in the near future, provided definite plans are made. He criticized the conservative viewpoint that suggests we should not even sit over a drawing board, but should wait until some revelation brings space flight into our laps.

It is suggestive, said von Braun, that modern telephone centrals and large aircraft depend on many thousands of tried and proven parts. The rocket world urgently needs to prove its mechanical components. Instead of producing a variety of spectacular tailor-made missiles and engines, von Braun suggests that effort be concentrated on a few standardized models and parts. Then, for instance, with proven motors a builder could produce a new missile with more confidence, because he would know what its power plant could do. Similarly, known rocket designs could incorporate experimental motors. When a larger rocket is to be built, clusters of tested engines could be used, instead of depending on a large but untried new motor.

FREDERICK I. ORDWAY

Amateur Astronomers

Western Amateurs Hold Fifth Convention

THE fifth annual convention of Western Amateur Astronomers on August 14-16 at Los Angeles was attended by 218 amateurs from California and neighboring states. The Los Angeles Astronomical Society was host.

The first day featured a trip to the Mount Wilson Observatory for dinner and a star party at which 79 telescopes were set up. The remaining days were devoted to sessions for papers. Among the addresses by professional astronomers were "General Conditions at the Moon's Surface," by Dinsmore Alter; "A New Light on Stellar Evolution," by Martin Schwarzschild; and "The Conquest of Space," by Robert S. Richardson. The sun was the subject of a talk by Seth B. Nicholson, and Paul Roques described some remarkable flare stars. George W. Bunton gave details on the new planetarium projector at the California Academy of Sciences in San Francisco.

The many papers given by amateurs covered subjects ranging from instrument making to lunar and planetary observations. Among the amateurs who spoke were Jackson Carle, Claude Carpenter, Leland S. Copeland, T. A. Cragg, Dr. C. P. Custer, Eugene Epstein, Clarence L. Friend, Walter H. Haas, Rolland LaPelle, Arthur S. Leonard, Richard Nigro, Carl Wells, and the undersigned.

After the dinner on Saturday evening, the convention enjoyed a "Stump the Experts" session, with Dr. Richardson as moderator of the panel of experts, which included both professionals and amateurs.

Between sessions, the board of representatives held meetings, with W. C. Marion as chairman. The societies with members on this board include Central Valley, Eastbay (Oakland), Excelsior (Long Beach), Los Angeles, Marin, Phoenix, Reno, Sacramento, San Diego, San Francisco, and Stockton. T. R. Cave, Jr., was elected chairman for the coming year. The next convention will be in San Francisco, with the San Francisco Amateur Astronomers as hosts.

Miss H. E. Neall
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Berkeley, Calif.

Northwest Convention

THE Amateur Telescope Makers of Spokane were hosts at the annual meeting of the Northwest region of the Astronomical League from July 31st to August 2nd. The meeting opened with an observing session at which Saturn, stars, and nebulae were viewed through several telescopes.

At the sessions for papers, P. T. Maher gave an account of his sunspot observations. He noted that support of the AAVSO Solar Division by the National Bureau of Standards had been discontinued after 11 years, and urged that local groups take up with their congressmen the need for further support. An unusual presentation was of a tape-recorded lecture on aurora observing by D. S. Kimball, of Yale University Observatory. This was illustrated by many slides of color photographs of aurorae.

John M. Holeman described some of the unusual new types of glass used at the Hanford atomic works in his paper, "Optical Instruments in the Dangerous Industries." To provide windows opaque to harmful radiations, a lead glass with the density of steel was developed, which can be made in blanks two feet thick and three feet square.

Forrest Moore, of Portland, Ore., was elected chairman of the Northwest region. It was voted that the Astronomical League be invited to hold its 1955 general convention in the Northwest.

Edward J. Newman
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Yakima, Wash.

THIS MONTH'S MEETINGS

Geneva, Ill.: Fox Valley Astronomical Society, 8 p.m., City Hall. Oct. 13, members, "Vacation Experiences."

Indianapolis, Ind.: Indiana Astronomical Society, 2:15 p.m., Cropsey Hall. Oct. 4, Dr. John B. Irwin, Indiana University, "Between the Stars."

Kalamazoo, Mich.: Kalamazoo Amateur Astronomical Association, 8 p.m., Western Michigan College. Oct. 17, Dr. Paul Rood, "The Spitz Planetarium."

New York, N. Y.: Amateur Astronomers Association, 8 p.m., American Museum of Natural History. Oct. 7, Charles A. Federer, Jr., editor, **Sky and Telescope**, "Astronomy in the Service of Man."

Washington, D. C.: National Capital Astronomers, 8:15 p.m., Commerce Department auditorium. Oct. 3, series of films, The Universe, by Dr. Ruroy Sibley.

NEW YORK CLASSES BEGIN

The Amateur Astronomers Association has begun its 27th year. Classes in elementary and intermediate astronomy, recent advances in astronomy, constellation study, and telescope mirror making are scheduled to begin early in October. Further information may be obtained from George V. Plachy, secretary, Amateur Astronomers Association, Hayden Planetarium, New York 24, N. Y.

The convention of Western Amateur Astronomers at the University of California at Los Angeles, August 14-16, 1953. Photograph by Al Frederic.

NEWS NOTES

By Dorrit Hoffleit

THE RED SHIFT

While the red shift in the spectra of galaxies is usually interpreted on the basis of an expanding universe, other explanations have been proposed from time to time. For instance, Zwicky has suggested that the apparent loss of energy of light from these distant objects is due to gravitational action.

In the British journal, *Observatory*, for April, H. S. Shelton gives a brief preliminary announcement of another hypothesis which, he states, needs further tests by physicists and astronomers. His proposal is that when a photon in free space collides with an electron or other fundamental particle, the wave length of the radiation is lengthened because of a transfer of kinetic energy to the particle, as in the Compton effect. Shelton's hypothesis would explain not only the red shift but also its linear increase with distance, provided intergalactic space contains these elementary particles; only within the galaxy is their existence generally recognized.

There is also a possibility that the buildup of the tremendous energies of cosmic rays may result from such interaction of light with particles in space.

NEW ECLIPSING VARIABLE STAR

An addition to the short but important list of eclipsing variables of spectral type *O* has been discovered by Dr. G. R. Miczaika, of the Heidelberg Observatory in Germany, who is now at Lick Observatory. His photoelectric observations, reported in the June *Publications* of the Astronomical Society of the Pacific, show that the 9th-magnitude star BD +40°4220 in Cygnus varies by 0.30 magnitude at primary minimum, in a period of 6.6 days. This discovery may yield important information on the dimensions of very massive stars.

FUNDAMENTAL STELLAR PHOTOMETRY

Professional astronomers will welcome a paper by H. L. Johnson and W. W. Morgan in the May *Astrophysical Journal* on the magnitudes and spectra of bright stars. A table is given of the spectral types and luminosity classes of over 300 stars, which are to serve as standards defining the revised Yerkes system of spectral classification. The authors outline a new fundamental system of photoelectric photometry. In this system, the zero point of the magnitudes is based on the revised visual north polar sequence; the color indices are defined as increasing by 1.00 magnitude over the interval *A*0 to g*K*0. Magnitudes and color indices from measurements in three wave lengths are given for 290 representative stars.

This paper will greatly aid widely separated observers in determining magnitudes, colors, and spectral types on a uniform basis.

ASTRONOMICAL LAWSUIT

The West German Astronomical Society is richer by $6,250 because of an obsolete theory, proposed and exploded nearly two centuries ago, that the sun is a cool, habitable globe surrounded by a hot veil. This fancy was recently revived by a German layman, Gottfried Bueren, who offered 25,000 marks to anyone who could disprove it. His challenge was taken up by the society. After lengthy legal proceedings, Bueren has been ordered by a court of appeals to pay this sum with costs, according to a Reuters dispatch.

RECORD ATTENDANCE AT GRIFFITH PLANETARIUM

"Space Station to the Moon" has been a recent feature at the planetarium of the Griffith Observatory in Hollywood. Public fascination with this modern topic, combined with the Boy Scout Jamboree in the Los Angeles area, resulted in new attendance records at the planetarium during the week of July 13-19. That week 10,082 persons (including 3,000 scouts) visited the planetarium. This was 3,900 more than in the corresponding week of 1952.

OPTICAL SOCIETY MEETING

The Optical Society of America will hold its annual meeting at Rochester, N. Y., on October 15, 16, and 17, 1953. The sessions, which will be held at Eastman House, are open to all persons interested.

IN THE CURRENT JOURNALS

SHELL STARS, by Paul W. Merrill, **Publications,** Astronomical Society of the Pacific, June, 1953. "Stars whose atmospheres are abnormally extended have intrigued astronomers ever since 1866 when Secchi discovered bright hydrogen lines in the spectra of the naked-eye stars γ Cassiopeiae and β Lyrae."

A NEWTON COLLECTION, by E. N. Da C. Andrade, **Endeavour,** April, 1953. "A collection of Newton books has not only the interest that must attach to anything intimately connected with one of the profoundest minds that ever lived, but is necessary for anyone who wishes to study the man."

ARTIFICIAL SATELLITE OR SPACE STATION, by Dinsmore Alter, **Griffith Observer,** July, 1953. "Astronomers and others of similar interests desire it because it will give to them observations of all of the solar spectrum, and also because it appears to them as a vital step toward travel to our moon."

METEORITICISTS MEET

On September 2-4, the Meteoritical Society held its first eastern meeting at the University of Pennsylvania in Philadelphia. The local committee was headed by Col. D. M. Barringer. The program included trips to the Cook and Flower observatories, the society dinner, and a tea and cocktail party on Col. Barringer's shady lawn.

Dr. C. P. Olivier, director of the Flower Observatory and head of the American Meteor Society, gave a history of that organization, whose aim has been not increased membership but more good observations of meteors. Many of the members contribute over 1,000 observations a year, and the files of the society contain some 400,000 records.

One of the most stimulating papers was by E. P. Henderson and Stuart Perry, of the U. S. National Museum, "The Goose Lake Meteorite from Modoc County, California." This meteorite contains cavities and tunnels much too deep to have been produced during the flight of the iron through our atmosphere, nor could they have been formed by weathering or other natural causes after impact. The cavities are wider beneath the surface than at the rim and all show a characteristic lip at the edges. No inclusions have been found in any of them. While the details of their origin are not yet explained, the authors feel that "cavities such as these give a clue to the conditions under which this iron formed."

Much discussion centered on meteorite craters, authentic and otherwise. The importance of publishing accurate descriptions and the setting up of criteria for the identification of meteorite craters was emphasized in various informal discussions. Perhaps most important would be criteria for rejecting as nonmeteoritic purely geologic or man-made craters.

Dr. V. Ben Meen, director of the Royal Ontario Museum of Geology and Mineralogy, gave a resume of the discovery and of what is known about two-mile-wide Chubb crater in Canada, which he had surveyed in 1951 with the support of the National Geographic Society. To this report he added the surprise announcement of another crater of possible meteoritic origin. About 555 feet in diameter, it lies some 450 miles east-southeast of Chubb crater, in northern Labrador between Hebron and Chimo.

This crater had been sighted some years ago by Col. Arthur F. Merewether, who later compared a photograph with published pictures of Chubb crater, and found that they were not the same. He communicated with Dr. Meen, and at the request of the National Geographic Society the latter flew to Labrador late in August this year. After a search of many hours the new crater was sighted, filled with murky "apple-green" water. While meteoritic origin has not been

proved in either case, that, at present, seems the most promising explanation for both of these craters until more thorough investigations can be carried out.

In a controversial paper, Dr. Clyde T. Hardy, of Utah State Agricultural College, defended a purely geological theory for the origin of Meteor Crater in Arizona, proposed earlier by Dorsey Hager. They find "overwhelming" evidence for a "tectonic-geomorphic" explanation, "most reasonable in view of similarities to other structural features in Arizona and Utah and in view of the likelihood of salt and gypsum underlying the area." These geologists contend that the world's widest-known distribution of meteorites in the identical area of such a pronounced "eroded dome" or "sinkhole" is purely coincidental. Meteoriticists ask, on the other hand, why deep drillings in the crater area have failed to reveal the salt and gypsum so important to the kind of geological feature described.

L. F. Brady, president of the society, reported on craters he had recently visited in the Sahara; these he will describe in the new journal *Meteoritics*. Here again the meteoritic origin is not established, for no meteorites were found, but he noted a high nickel-iron content in the surrounding sands.

Approximate orbits of two widely observed fireballs were given by Dr. C. C. Wylie and George E. Collins, of the State University of Iowa. One of these, seen from western Minnesota on July 19, 1953, had a semimajor axis of 2.59 astronomical units and a period of 4.2 years. The other, from less consistent observations in Missouri on July 6, 1953, had corresponding values of 0.84 A.U. and 0.77 year. It is fairly certain that both periods must have been very short in comparison with the periods of ordinary shower meteors.

THE INDEX TO VOLUME XII

of *Sky and Telescope* is included in the center of this issue. It may be removed for binding purposes by opening the staples. Indexes to Volumes I through IX are available, at 35 cents each postpaid. The indexes for Volumes X and XI are included in the issues of October, 1951 and 1952, respectively.

BINDERS

for *Sky and Telescope* are available. These are of the loose-leaf type, in which each issue may be filed as it is received. Covered with dark blue fabrikoid, the binders may be reused from year to year or kept as permanent binding for separate volumes. Each binder costs $3.50 postpaid in the United States, $4.00 in Canada. No orders from foreign countries can be accepted. Your name can be gold-stamped for 70 cents extra, the volume number for 40 cents, both for $1.00; print desired lettering clearly. Payment must accompany your order.

SKY PUBLISHING CORPORATION
Harvard College Observatory
Cambridge 38, Massachusetts

ALASKAN COSMIC RAY OBSERVATORY

Under the joint sponsorship of New York University and the University of Alaska, a permanent observing station has been established on the 14,006-foot summit of Mt. Wrangell in Alaska. The new observatory will be devoted to research in cosmic radiation, high-altitude biology, and meteorology, under the direction of Dr. Serge A. Korff and Dr. Terris Moore. The mountain station is so inaccessible that it will have to be supplied by air.

IN FOCUS

(Continued from page 310)

was taken 20 minutes before the lower picture in blue light. Both show the satellite Ganymede and its shadow on the planet. Their motion during the interval is evident. The great red spot in Jupiter's southern hemisphere appears as a dark marking on the blue photograph, but is inconspicuous on the red. At the same time, much fine detail in Jupiter's dark belts is evident in red light but not in blue. The edge of Jupiter is considerably darker in the upper picture than in the lower. This implies that we can see deeper into Jupiter's atmosphere with red light than with blue. Consequently, photography of this planet in light of different wave lengths offers the interesting possibility of studying its cloud formations at different levels.

Planetarium Notes

BALTIMORE: *Davis Planetarium.* Maryland Academy of Sciences, Enoch Pratt Library Building, 400 Cathedral St., Baltimore 1, Md., Mulberry 2370.

SCHEDULE: 4 p.m. Monday, Wednesday, and Friday; Thursday evening, 7:45, 8:30, 9:30 p.m. Admission free. Spitz projector. Director, Paul S. Watson.

BUFFALO: *Buffalo Museum of Science Planetarium.* Humboldt Parkway, Buffalo, N. Y., GR-4100.

SCHEDULE: Sundays, 2:00 to 5:30 p.m. Admission free. Spitz projector.

CHAPEL HILL: *Morehead Planetarium.* University of North Carolina, Chapel Hill, N.C.

SCHEDULE: Daily at 8:30 p.m.; Saturday and Sunday at 3:00 p.m. Zeiss projector. Manager, A. F. Jenzano.

CHARLESTON, W. VA.: *Hillis Townsend Planetarium.* Public Library Building, Charleston, W. Va.

SCHEDULE: Saturday, 11:15 a.m. Special showings on request. Admission free. Spitz projector. Director, Louise L. Morlang.

CHEROKEE, IA.: *Sanford Museum Planetarium.* Sanford Museum, 117 E. Willow St., Cherokee, Ia.

SCHEDULE: Monday, 8 p.m. (except August). Admission free. Spitz projector. Director, W. D. Frankforter.

CHICAGO: *Adler Planetarium.* 900 E. Achsah Bond Drive, Chicago 5, Ill., Wabash 1428.

SCHEDULE: Mondays through Saturdays, 11 a.m. and 3 p.m.; Sundays, 2:00 and 3:30 p.m. Zeiss projector. Director, Wagner Schlesinger.

KANSAS CITY: *Kansas City Museum Planetarium.* 3218 Gladstone Blvd., Kansas City 1, Mo., Chestnut 2215.

SCHEDULE: Saturday, 3:00 p.m.; Sunday, 3:00 p.m. Spitz projector. Director, Charles G. Wilder.

LOS ANGELES: *Griffith Observatory and Planetarium.* Griffith Park, P. O. Box 27787, Los Feliz Station, Los Angeles 27, Calif., Olympia 1191.

SCHEDULE: Wednesday, Thursday, and Friday at 8:30 p.m.; Saturday and Sunday at 3 and 8:30 p.m.; extra show on Sunday at 4:15 p.m. Zeiss projector. Director, Dinsmore Alter.

NASHVILLE: *Sudekum Planetarium.* Children's Museum, 724 2nd Ave. S., Nashville 10, Tenn., 42-1858.

SCHEDULE: Sunday, 2:45, 3:30, 4:15. Spitz projector. Supervising lecturer, James C. Foster.

NEWARK: *Newark Museum Planetarium.* 49 Washington St., Newark 1, N. J., Mitchell 2-0011.

SCHEDULE: Saturday, 2 and 3 p.m.; Sunday, 2:15 and 3:15 p.m.; Wednesday, 8 p.m. Spitz projector. In charge, Ray Stein.

NEW YORK CITY: *Hayden Planetarium.* 81st St. and Central Park West, New York 24, N. Y., Trafalgar 3-1300.

SCHEDULE: Mondays through Fridays, 2, 3:30, and 8:30 p.m.; Saturdays, 11 a.m., 2, 3, 4, 5, and 8:30 p.m.; Sundays and holidays, 2, 3, 4, 5, and 8:30 p.m.; Wednesdays and Fridays, 11 a.m., for school groups. Zeiss projector.

PHILADELPHIA: *Fels Planetarium.* Franklin Institute, 20th St. at Benjamin Franklin Parkway, Philadelphia 3, Pa., Locust 4-3600.

SCHEDULE: Tuesdays through Sundays, 3 p.m.; Saturdays, 11 a.m.; Saturdays, Sundays, and holidays, 2 p.m.; Wednesdays, Fridays, and Saturdays, 8:30 p.m. Zeiss projector. Director, I. M. Levitt.

PITTSBURGH: *Buhl Planetarium and Institute of Popular Science.* Federal and West Ohio Sts., Pittsburgh 12, Pa., Fairfax 4300.

SCHEDULE: Mondays through Saturdays, 2:15 and 8:30 p.m.; Sundays and holidays, 2:15, 3:15 and 8:30 p.m. Zeiss projector. Director, Arthur L. Draper.

PORTLAND, ORE.: *Oregon Museum of Science and Industry Planetarium.* 908 N.E. Hassalo St., Portland 12, Ore., East 3807.

SCHEDULE: Saturday, Sunday, and Wednesday, 4:00 p.m.; Tuesday, Thursday, and Friday, 8:00 p.m.; Saturday show for children only, 10:30 a.m. Spitz projector. Director, Stanley H. Shirk.

PROVIDENCE, R. I.: *Roger Williams Planetarium.* Roger Williams Park Museum, Providence 5, R. I., Williams 1-5640.

SCHEDULE: Wednesday at 3:30 p.m.; Saturday at 10:30 a.m., 2:30 and 3:30 p.m.; Sunday, 2 to 5 p.m. Admission free. Spitz projector. Director, Maribelle Cormack.

SAN FRANCISCO: *Morrison Planetarium.* California Academy of Sciences, Golden Gate Park, San Francisco 18, Calif., Bayview 1-5100.

SCHEDULE: Daily (except Monday and Tuesday) at 3:30, 7:30, and 9 p.m.; also at 2 p.m. on weekends and holidays. Academy projector. Manager, George W. Bunton.

SPRINGFIELD, MASS.: *Seymour Planetarium.* Museum of Natural History, Springfield 5, Mass.

SCHEDULE: Tuesdays, Thursdays, and Saturdays at 3 p.m.; Tuesday evenings at 8 p.m.; special star stories for children on Saturdays at 2 p.m. Admission free. Korkosz projector. Director, Frank D. Korkosz.

STAMFORD: *Stamford Museum Planetarium.* Courtland Park, Stamford, Conn.

SCHEDULE: Sunday, 4:00 p.m. Admission free. Spitz projector. Director, Ernest T. Luhde.

BOOKS AND THE SKY

WAVES AND TIDES

R. C. H. Russell and D. H. Macmillan. Philosophical Library, New York, 1953. 348 pages. $6.00.

THE TIDES form a real link between the science of astronomy and the practical world, for here is a phenomenon of great economic importance which can be explained and predicted only by recourse to astronomy. Knowledge of the moon's motion takes on a dollars-and-cents value when translated into tidal tables, without which large modern ships could not safely venture into ports like New York or Hamburg.

While every general text on astronomy says something about the tides, the treatment is ordinarily too slight, and does not satisfy the reader. And yet the subject can be absorbing when expanded into a popular book, as George Darwin proved with his classic **The Tides.** However, Darwin's book is now badly out of date in the practical aspects of his theme. Comdr. Macmillan's discussion of the tides is therefore very welcome. Writing for the informed layman, he describes the tidal phenomena and explains luminously the principles of tidal theory, then proceeding to the measurement and practical prediction of tides. Particularly valuable is his account of recent advances in tidal research, which have not hitherto been available in such convenient and readable form. The whole discussion should prove most useful to teachers of astronomy, who often find the tides a troublesome topic to present.

The subject of water waves is closely intertwined with the tides, and the two are profitably considered together. In the first half of the book under review, R. C. H. Russell has dealt competently with waves. Perhaps it is not sufficiently appreciated how interesting a field of study for the amateur scientist is offered by ocean waves. This book will suggest many projects for which little or no equipment is required. Two aspects of waves have been particularly considered, the relation of their sizes to meteorological conditions, and practical applications, such as the effects of waves upon breakwaters and other man-made structures, and the formation and erosion of beaches. Both aspects are of obvious military importance, so that during World War II extensive wave investigations were carried out by British and American naval research groups. Many of these studies have hitherto been buried in official reports, and it is a particular merit of this book to have made their results generally accessible.

Waves and Tides is written for the intelligent lay reader. Although simple formulae are used fairly freely, nothing beyond high school mathematics is needed to follow the discussion. The diagrams are numerous and easy to read. Particularly noteworthy are the fine photographs of waves. There are very few obvious errors; Texans will notice that on page 300 the date of the Galveston flood should be 1900 and not 1850.

It is to be hoped that when this book appears in a second edition more space can be found for some wider aspects of tidal phenomena. Nothing is said of earth tides or atmospheric tides, and the gradual yet important slowing of the earth's rotation by tidal friction has been dismissed in two sentences. Even though it is necessary to turn elsewhere for these topics, **Waves and Tides** is well worth reading.

JOSEPH ASHBROOK

NEW BOOKS RECEIVED

A HISTORY OF ASTRONOMY FROM THALES TO KEPLER, *J. L. E. Dreyer*, 1953, *Dover.* 438 pages. $3.95 cloth, $1.95 paper.

This edition introduces some very minor changes from the original edition of 1906, which was entitled, *History of the Planetary Systems from Thales to Kepler.* This well-known classic has long been a standard reference on Greek astronomy and the Copernican revolution. A bibliography has been added listing the more important supplementary reading that has appeared since the first edition.

THE WORKS OF ARCHIMEDES, *T. L. Heath*, editor, 1953, reissue of 1897 edition plus 1912 supplement, *Dover.* 186 + 326 + 51 pages. $4.95 cloth, $1.95 paper.

This is an English translation of the extant mathematical works of Archimedes, with his demonstrations expressed in modern notation. An introductory essay of 186 pages analyzes the content of Archimedes' work and his place in the history of mathematics. The new printing includes a translation of the important treatise, "On Method," discovered in 1906 and published by Heath in 1912.

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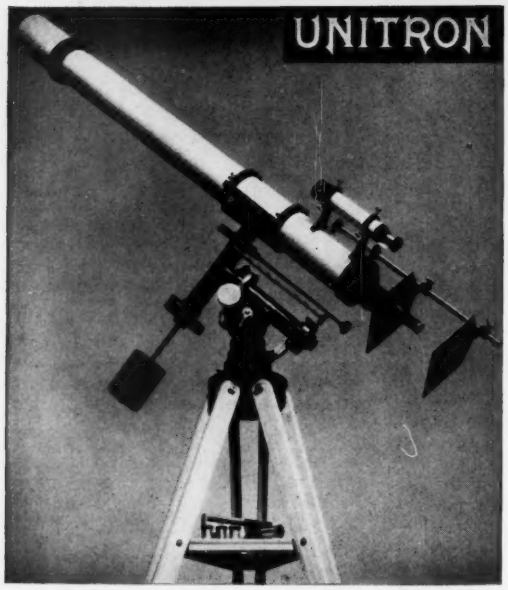

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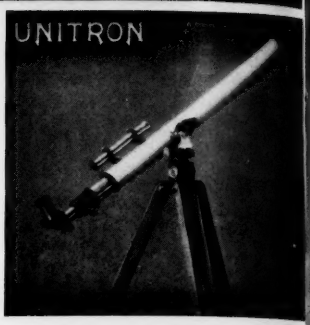

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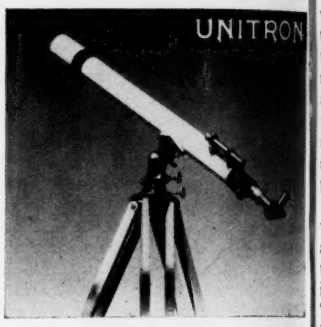

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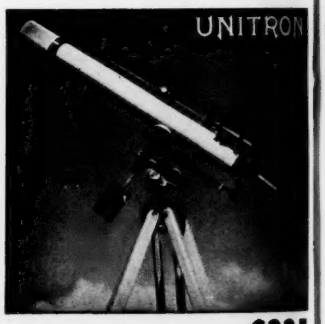

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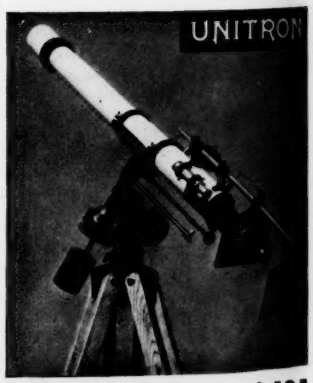

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GLEANINGS FOR ATM's

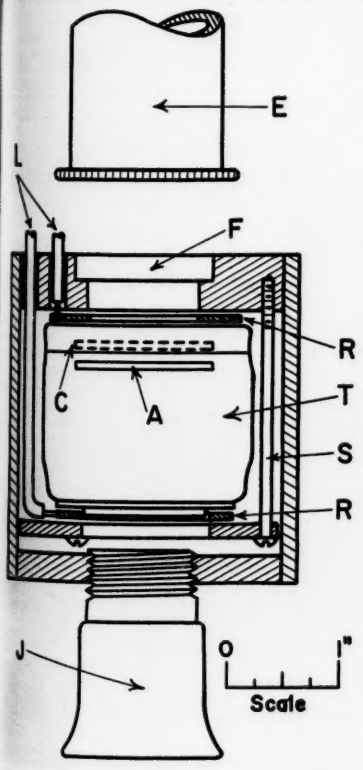
EDITED BY EARLE B. BROWN

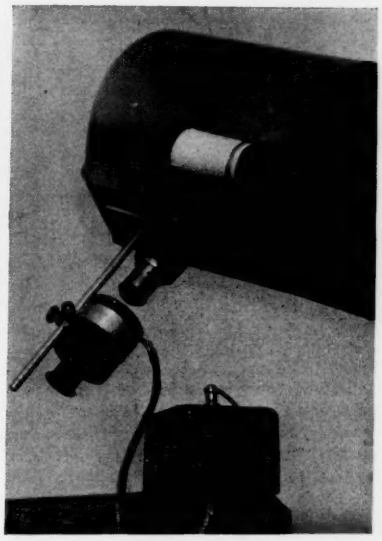
An Electronic Eyepiece for Astronomical Telescopes

SINCE the end of the war several types of electronic image converter tubes have been offered for sale on the surplus market. At the present time the simplest of these, a British tube, is available for less than five dollars. An image converter is basically similar to an ordinary vacuum photocell, except that electrons which are released from the cathode under the stimulus of radiation are actually imaged on a fluorescent screen instead of merely being collected and registered as an electric current.

While the sensitivity of the image converter to visible light is far less than that of the unaided eye, its response extends well into the infrared and ultraviolet portions of the spectrum where human vision fails completely. These normally invisible radiations, when imaged on the cathode, are converted to visible green images on the screen of the tube, so that visual observations may be made in regions of the spectrum ordinarily accessible only to the photographic plate.

The diagram is of a simple image converter unit used by the writer in making a number of successful observations of the moon, the sun, and Venus with an 8-inch reflecting telescope. The image tube **T** has a transparent window and an annular electrode at each end. Contact rings **R** are clamped against these electrodes by means of three screws **S**. High-voltage leads **L** are soldered to the contact rings. The eyepiece **E** of the telescope projects an image on the cathode **C** of the image tube. A jeweler's loupe **J** is used to view





The image converter unit attached to Alex. G. Smith's 8-inch reflector requires the 4,000-volt transformer shown on the table in this picture.

the fluorescent image on the screen **A**. The magnification may be varied either by changing eyepieces or by altering the distance between the eyepiece and the converter. Observations are made in ultraviolet or infrared radiation by placing the appropriate filter in the recess **F**. Filters may be obtained from photographic dealers or from scientific supply houses. Except for the contact rings, my unit was constructed of bakelite, but well-shellacked cardboard and wood should serve as well, and the loupe might be replaced by any positive lens of similar focal length.

It is necessary to provide a high-voltage power supply for the image converter, but the voltage is not critical. Any source, AC or DC, which will supply from 2,000 to 5,000 volts at a current drain of less than a milliampere will do. Image brightness and resolving power are somewhat improved at the higher voltages. An inexpensive neon sign transformer is quite adequate, and is probably available in most localities. Any exposed terminals should be covered to prevent accidental contact, and the high-tension leads to the image converter must be heavily insulated, preferably of auto ignition cable. It is desirable to place a small radio resistor of about a million ohms in each lead to limit the current that can be drawn if the leads should be short-circuited; this will also reduce the hazard to the operator. If a DC source should be employed, the positive terminal must be connected to the lower contact ring in the diagram. The picture shows the image converter unit attached to the writer's 8-inch reflector, and it also shows a small 4,000-volt power supply.

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are possible on the moon and Venus before the image becomes excessively faint. Views of the moon in infrared or ultraviolet light differ in many details from normal lunar appearances, and markings on Venus have been detected in ultraviolet light which were completely invisible in ordinary light.

The writer's observations of this kind have been described more fully in **The Strolling Astronomer** (Vol. 7, page 72, 1953), published by the Association of Lunar and Planetary Observers. Planetary observers will find this a very valuable method for the systematic study of markings on Venus, which are seldom distinct enough for visual observation. [This may make available a rich new field for the amateur observer.—ED.]

Sunspots are also readily visible, but planets other than Venus are unfortunately not bright enough to show surface detail with the writer's equipment, although this would not necessarily be the case with a larger telescope.

Tests made on stars indicate that a telescope equipped with this type of image converter is about seven magnitudes less sensitive than the same instrument used visually. In spite of this rather formidable loss, the image of the moon on the screen of the converter has been successfully photographed with an exposure of 1/5 second at f/2.8. Maximum emulsion speed was obtained by processing Plus-X film in SD-19a developer. The image converter has also given good results on the moon with a small refractor of only two inches aperture.

ALEX. G. SMITH
University of Florida
Gainesville, Fla.

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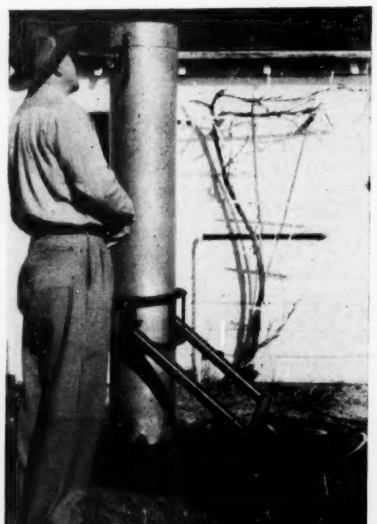
MY TELESCOPE is a Newtonian reflector with a 10-inch pyrex mirror of 69 inches focal length. The mirror is not aluminized, since in the Sacramento climate a good double coat of silver will last more than a year, provided the end of the tube is covered when the telescope is not in use. I have found that the silver



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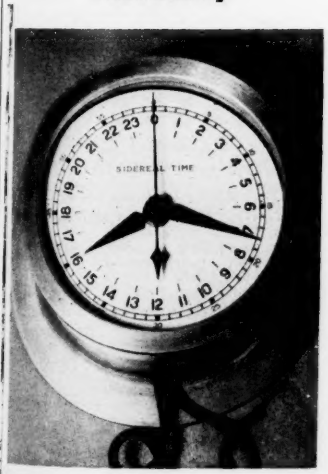

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A closeup of Mr. Ward's mounting.

will not tarnish if a lump of camphor gum is kept in the tube.

The telescope is driven by an 1,800-r.p.m. electric motor from a wire recorder. In the drive train is a friction clutch, which is a great convenience as it allows the telescope to be moved in right ascension without unclamping, and avoids accidental damage to the drive gears. This clutch consists of a rubber tire, one inch in diameter, which rides a 3-inch friction disk, ground true from a piece of truck tire that is clamped between two metal washers. The motor unit is hinged so that the rubber tire is held against the friction disk by gravity. The drive speed can be adjusted by a screw which moves the tire shaft parallel to its length, changing the distance of the tire from the center of the friction disk. To reduce vibration, the motor and small drive wheel are mounted on rubber bands.

The accompanying pictures show how the telescope tube is mounted. The fork mounting is of boiler tubing. The declination axis is attached to two Ford ring gears, inside each of which ride four rollers; these are supported by a split iron band that grips the tube, permitting the latter to be turned for convenient location of the eyepiece. The split rings can be loosened to permit slipping the tube to attain perfect balance. I am five feet, 10 inches tall, and I can stand on the sidewalk and look in the eyepiece with the telescope pointed to the zenith.

The prism used for the secondary reflection is mounted so that I can turn it over and have an unsilvered surface for cutting down the glare of the moon when it is at or near the full phase.

The best planetary views are obtained with this instrument through a 1½-inch orthoscopic eyepiece in conjunction with a 3-inch Barlow lens. This telescope shows six stars in the Orion Trapezium. When the polar axis is fairly well oriented, the drive will keep a planet in the field for an hour, and then the shift is only in declination.

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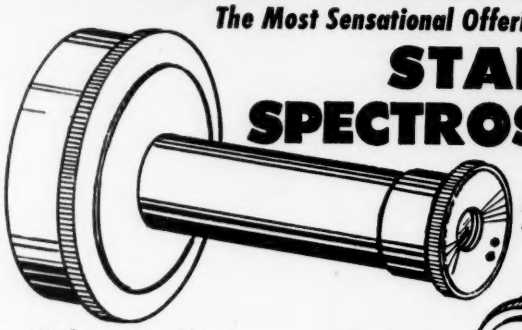

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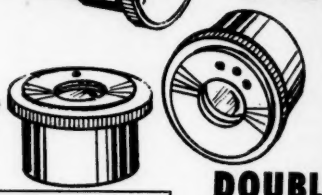

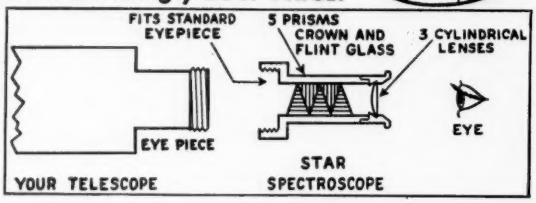

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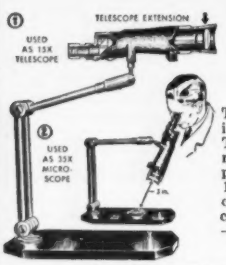

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OBSERVER'S PAGE

Universal time is used unless otherwise noted.

An Introduction to Observing Jupiter — II

Through a Larger Instrument

Drawings of Jupiter by D. P. Avigliano, showing the planet's appearance in a 6-inch reflector, left, and in a 12½-inch reflector, right.

On turning a 6- to 12-inch telescope upon Jupiter and applying a power of 200x or 250x, we will find that the cloud belts show very rich detail. The dark belts can be interrupted, notched or with wavy outlines, and sometimes they form loops or festoons. At times there are oblique, curved, or ragged streaks seen on the disk. Dark wisps are often detected between the belts. Both dark and light spots of different sizes sometimes appear on various parts of the planet.

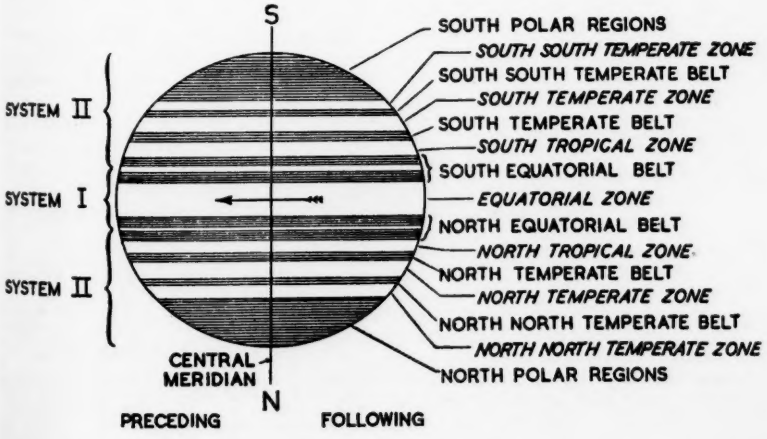
Some of the markings on Jupiter have been found to be exceptionally long lasting. The most famous is the great red spot. This first came under the systematic attention of astronomers in 1878, but there is evidence of it having been seen earlier. It is a large oval spot in the southern hemisphere of the planet. (The spot is conspicuous on one back-cover 200-inch photograph.) In recent years the spot itself has grown dim and it is now usually difficult to make out, but its location can still be easily found by the bay in which it lies. This bay forms a curved rift in the south component of the south equatorial belt. The rift can ordinarily be found under good conditions even though the spot itself might not be seen. Other long-enduring markings have been noted, but none with the persistence of the red spot.

In regard to the axial rotation of the planet, there are two separate times listed in the table published last month. This is because the various zones and some of the specific markings rotate at different rates of speed. The speeds of rotation of specific markings, their individual movements, and the length of time that these markings can be recognized make a very interesting study for the advanced amateur. The equatorial zone has a rotation period of about $9^h\ 50^m$ (System I), the temperate zones about $9^h\ 56^m$ (System II). It may be noted here that the belts will probably not be seen as shown in the diagram; there will be individual variation, and all of the belts diagrammed will not generally be noted at the same time due to the combination of seeing conditions, quality of instrument used, and changes in the belts themselves. The diagram, however, will serve to orient the student of Jupiter as to general observation areas.

An observer wishing to make drawings for future study may observe both sides of the planet by making a second observation approximately one hour later on the night following the original drawing, as the planet will have made about 2½ rotations in the intervening time. If the planet is observed on the third night, another hour later, the side originally viewed will again be seen. Should the observer wish to study the changes in position of the markings on the disk, the Jovian longitude of the central meridian of the planet for any specific time can be obtained from the **American Ephemeris.** This information is given for both System I and System II. The transit of a marking across the central meridian of the disk may be timed to the nearest minute. The longitude of the marking is then equal to the longitude of the central meridian at that time. By comparing several such longitude determinations of the same marking, we can trace the drift of the marking. During the long winter nights of Jupiter's coming opposition, 10 hours of observation will show a complete rotation of the planet.

On exceptionally fine nights the colors of the satellites and on the disk of Jupiter can be studied to advantage. The larger belts will usually be seen as reddish in hue. The polar areas fade off into bluish-gray tones. Other colors are occasionally seen, especially in the equatorial area. Light pink, salmon, and even light green have been recorded.

D. P. AVIGLIANO
2600 E. Orange Grove Ave.
Pasadena 8, Calif.



The nomenclature of Jupiter's principal belts and zones, from "The British Astronomical Association, Its Nature, Aims and Methods."

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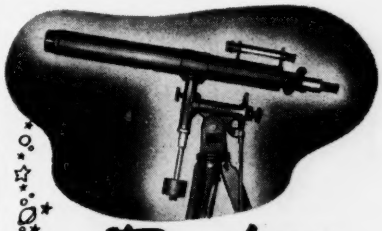

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DEEP-SKY WONDERS

IN a department such as this, it is to be expected that the Messier objects should appear frequently, as they for the most part are the big, bright ones best suited to amateur observation. Indeed, in various cities there are Messier clubs in which the amateur attempts to observe each object on that famous list. Such a program affords much pleasure and a comprehensive education in the wonders of the nebulae and clusters.

To date, we have made some mention of all of the Messier list, but a few of his objects have not been talked about for almost 10 years. Of these M52, NGC 7654, has suffered the most. It lies between Cassiopeia and Cepheus at $23^h\ 22^m.0$, $+61°\ 20'$, on the edge of the dark lane in the Milky Way that divides these two constellations. Indeed, it is only the 1930 boundary changes by the IAU that put it in Cassiopeia at all — the early writers discuss the object under Cepheus, and there one should look for its description in Smyth or Webb. Not large as galactic clusters go, it is 13′ in diameter, but packed into that area are more than 150 stars of the 11th magnitude and fainter. If it were not for its irregular outlines, M52 might well be mistaken for a globular cluster.

WALTER SCOTT HOUSTON

OCCULTATION PREDICTIONS

October 25-26 **125 Tauri** 5.0, 5:36.8 +25-52.4, 18, Em: **A** 10:19.3 −1.2 −1.9 297; **B** 10:11.9 −1.1 −2.2 305; **C** 10:18.2 −1.6 −1.2 280; **D** 10:07.9 −1.5 −1.6 294; **E** 9:51.2 −2.0 −0.4 274; **F** 9:29.4 −2.4 +1.9 239; **G** 9:00.0 −1.8 −1.8 322; **H** 8:52.0 −1.6 +0.9 270; **I** 8:45.4 −1.9 −1.8 326.

For standard stations in the United States and Canada, for stars of magnitude 5.0 or brighter, data from the **American Ephemeris** and the **British Nautical Almanac** are given here, as follows: evening-morning date, star name, magnitude, right ascension in hours and minutes, declination in degrees and minutes, moon's age in days, immersion or emersion; standard station designation, UT, **a** and **b** quantities in minutes, position angle on the moon's limb; the same data for each standard station westward.

The **a** and **b** quantities tabulated in each case are variations of standard-station predicted times per degree of longitude and of latitude, respectively, enabling computation of fairly accurate times for one's local station (long. **Lo**, lat. **L**) within 200 or 300 miles of a standard station (long. **LoS**, lat. **LS**). Multiply **a** by the difference in longitude (**Lo** — **LoS**), and multiply **b** by the difference in latitude (**L** — **LS**), with due regard to arithmetic signs, and add both results to (or subtract from, as the case may be) the standard-station predicted time to obtain time at the local station. Then convert the Universal time to your standard time.

Longitudes and latitudes of standard stations are:

A	+72°.5, +42°.5	**E**	+91°.0, +40°.0
B	+73°.6, +45°.6	**F**	+98°.0, +31°.0
C	+77°.1, +38°.9	**G**	+114°.0, +50°.9
D	+79°.4, +43°.7	**H**	+120°.0, +36°.0
		I	+123°.1, +49°.5

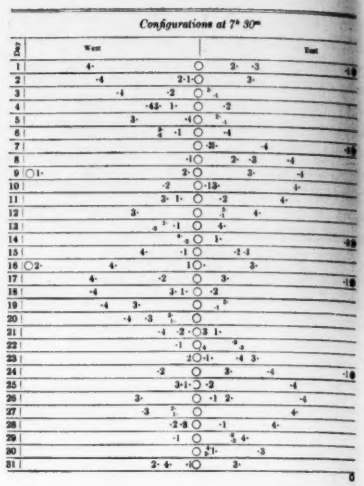
SOLAR ACTIVITY

On August 13th, at the McMath-Hulbert Observatory, Dr. Helen W. Dodson observed a very small well-defined sunspot at 52° north solar latitude; this spot probably marks the onset of another cycle of solar activity.

A large sunspot group about 140,000 kilometers long, with a leading spot of 36,000 kilometers, crossed the sun's central meridian on August 22, 1953, according to Herbert A. Luft, Elmhurst, N. Y. He counted 32 single spots in this group with a 54-mm. refractor at 96 power.

JUPITER'S SATELLITES

Jupiter's four bright moons have the positions shown below for the Universal time given. The motion of each satellite is from the dot to the number designating it. Transits of satellites over Jupiter's disk are shown by open circles at the left, eclipses and occultations by black disks at the right. The chart is from the **American Ephemeris and Nautical Almanac.**



VARIABLE STAR MAXIMA

October 4, R Octantis, 055**86,** 7.9; 7, V Cassiopeiae, 230**759,** 7.9; 14, R Aquarii, 233**815,** 7.3; 16, S Pavonis, 194**659,** 7.3; 24, V Ophiuchi, 162**112,** 7.5; 27, RU Cygni, 213**753,** 8.0. November 1, R Leonis Minoris, 093**934,** 7.2; 2, RU Sagittarii, 195**142,** 7.2; 3, T Normae, 153**654,** 7.4; 3, T Aquarii, 204**405,** 7.9.

These predictions of variable star maxima are by the AAVSO. Only stars are included whose mean maximum magnitudes are brighter than magnitude 8.0. Some, but not all of them, are nearly as bright as maximum two or three weeks before and after the dates for maximum. The data given include, in order, the day of the month near which the maximum should occur, the star name, the star designation number, which gives the rough right ascension (first four figures) and declination (bold face if southern), and the predicted magnitude.

PREDICTIONS OF BRIGHT MINOR PLANET POSITIONS

Harmonia, 40, 9.0. Oct. 20, 4:05.0 +15-24; 30, 3:58.2 +15-07. Nov. 9, 3:48.8 +14-47; 19, 3:38.0 +14-28; 29, 3:27.2 +14-14. Dec. 9, 3:18.1 +14-09.

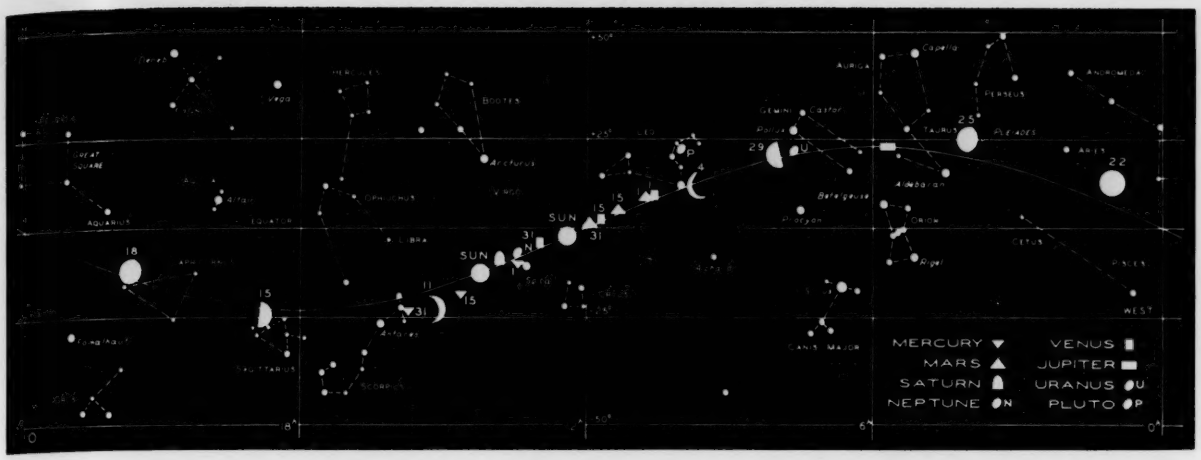
Eunike, 185, 9.5. Oct. 30, 3:59.1 −16-01. Nov. 9, 3:51.7 −17-20; 19, 3:43.1 −18-04; 29, 3:34.6 −18-10. Dec. 9, 3:27.3 −17-38; 19, 3:21.8 −16-31.

Nysa, 44, 9.2. Oct. 30, 4:03.3 +14-18. Nov. 9, 3:55.4 +13-44; 19, 3:45.7 +13-13; 29, 3:35.6 +12-46. Dec. 9, 3:26.6 +12-31; 19, 3:20.0 +12-31.

After the asteroid's name are its number and the magnitude expected at opposition. At 10-day intervals are given its right ascension and declination (1953.0) for 0^h Universal time. In each case the motion of the asteroid is retrograde. Data supplied by the IAU Minor Planet Center at the University of Cincinnati Observatory.

UNIVERSAL TIME (UT)

TIMES used on the Observer's Page are Greenwich civil or Universal time, unless otherwise noted. This is 24-hour time, from midnight to midnight; times greater than 12:00 are p.m. Subtract the following hours to convert to standard times in the United States: EST, 5; CST, 6; MST, 7; PST, 8. If necessary, add 24 hours to the UT before subtracting, and the result is your standard time on the day preceding the Greenwich date shown.



THE SUN, MOON, AND PLANETS THIS MONTH

The sun, on the ecliptic, is shown for the beginning and end of the month. The moon's symbols give its phase roughly, with the date marked alongside. Each planet is located for the middle of the month and for other dates shown.

Mercury will be in the evening sky all month, but poorly situated for viewing in northern latitudes. Greatest elongation occurs on October 23rd, 24° 18′ east of the sun. At that time the planet, at magnitude +0.1, sets less than one hour after the sun.

Venus, slowly approaching the sun in the morning sky, rises two hours ahead of it in mid-October. A very close conjunction of Mars and Venus occurs on October 4th at 6:00 UT. The pair will be separated by 2′, with Venus to the south. Because Venus is brighter than Mars by five magnitudes, the conjunction will not be visible to the naked eye. However, in binoculars or a telescope this will be a beautiful sight, with Venus 12″ in diameter, 87% illuminated, and Mars 4″ in diameter. The following morning, the pair may be seen with the unaided eye, and the crescent moon will be 5° to the south of the two planets.

Mars rises three hours ahead of the sun late in the month, and is of little interest except for the close conjunction with Venus described above.

Jupiter will rise about 3½ hours after sunset in mid-October. Retrograde motion commences on the 15th, preceding opposition in December. Jupiter is located in eastern Taurus, at magnitude —2.1, and in a telescope presents a disk 43″ in equatorial diameter.

Saturn cannot be viewed this month, as it passes conjunction with the sun on the 23rd.

Uranus comes to western quadrature on the 16th, rising before midnight, local time. It is approximately 2½° south of Kappa Geminorum and virtually stationary all month, with retrograde motion beginning on October 29th.

Neptune is in conjunction on October 17th, entering the morning sky at that time.

E. O.

METEORS IN OCTOBER

The Orionid meteor shower reaches maximum on October 19-20, but observation will be hampered by a nearly full moon in western Pisces. The duration of the shower is about 10 days, with the radiant roughly 10° northeast of Betelgeuse. Rates are 20 per hour, with swift meteors characteristic of this shower. Beginning in late October, reaching maximum the first 10 days of November, the Taurid meteors may be observed, with expected rates of about six per hour.

E. O.

MOON PHASES AND DISTANCE

New moon	October 8,	0:40
First quarter	October 15,	21:44
Full moon	October 22,	12:56
Last quarter	October 29,	13:09
New moon	November 6,	17:58

	October		Distance	Diameter
Apogee	6,	18h	252,600 mi.	29′ 23″
Perigee	21,	16h	222,600 mi.	33′ 22″
	November			
Apogee	3,	2h	252,200 mi.	29′ 26″

MINIMA OF ALGOL

October 3, 9:49; 6, 6:38; 9, 3:26; 12, 0:15; 14, 21:04; 17, 17:53; 20, 14:41; 23, 11:30; 26, 8:19; 29, 5:08. November 1, 1:57.

These minima predictions for Algol are taken from the 1953 **Handbook** of the Royal Astronomical Society of Canada.

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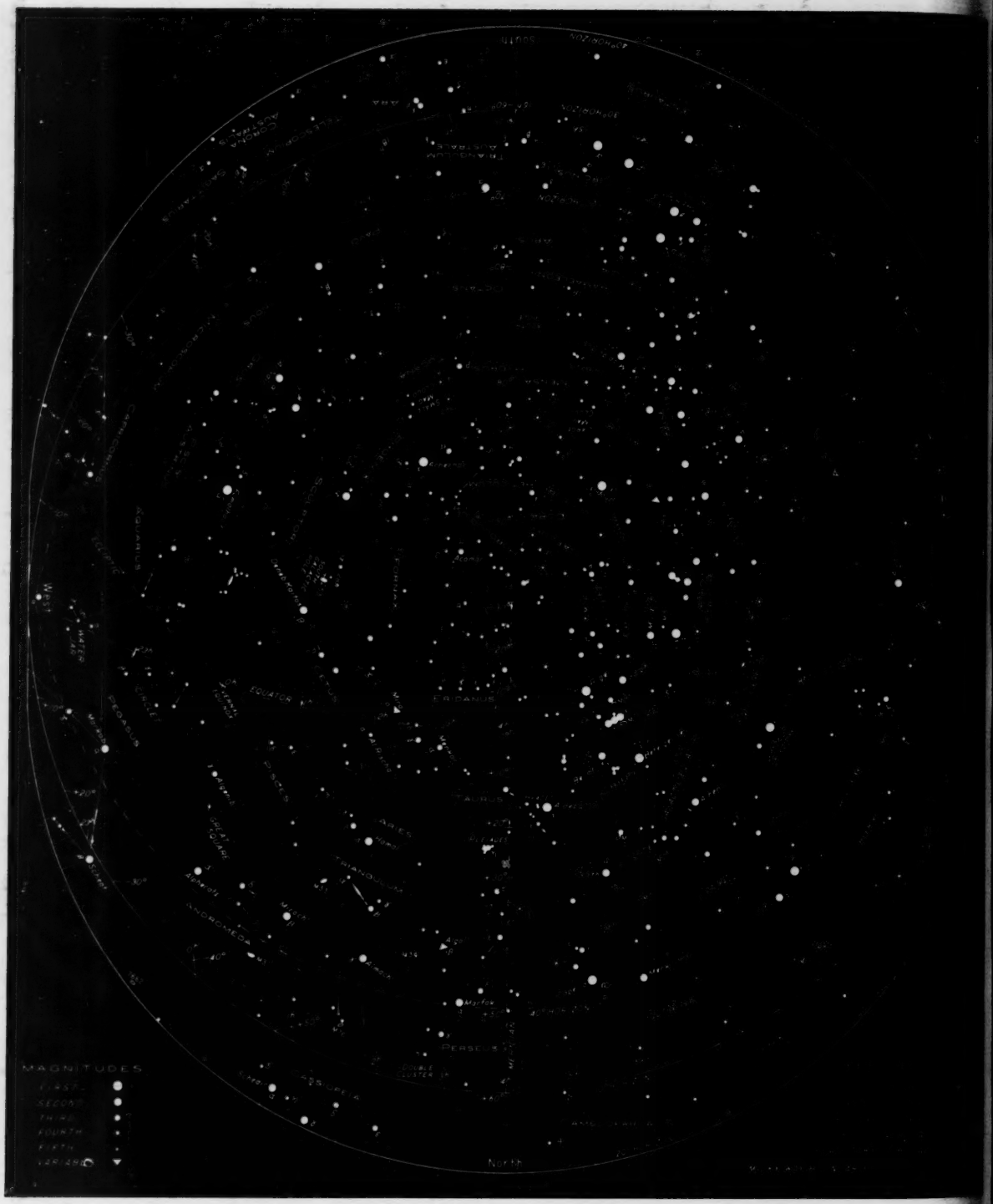


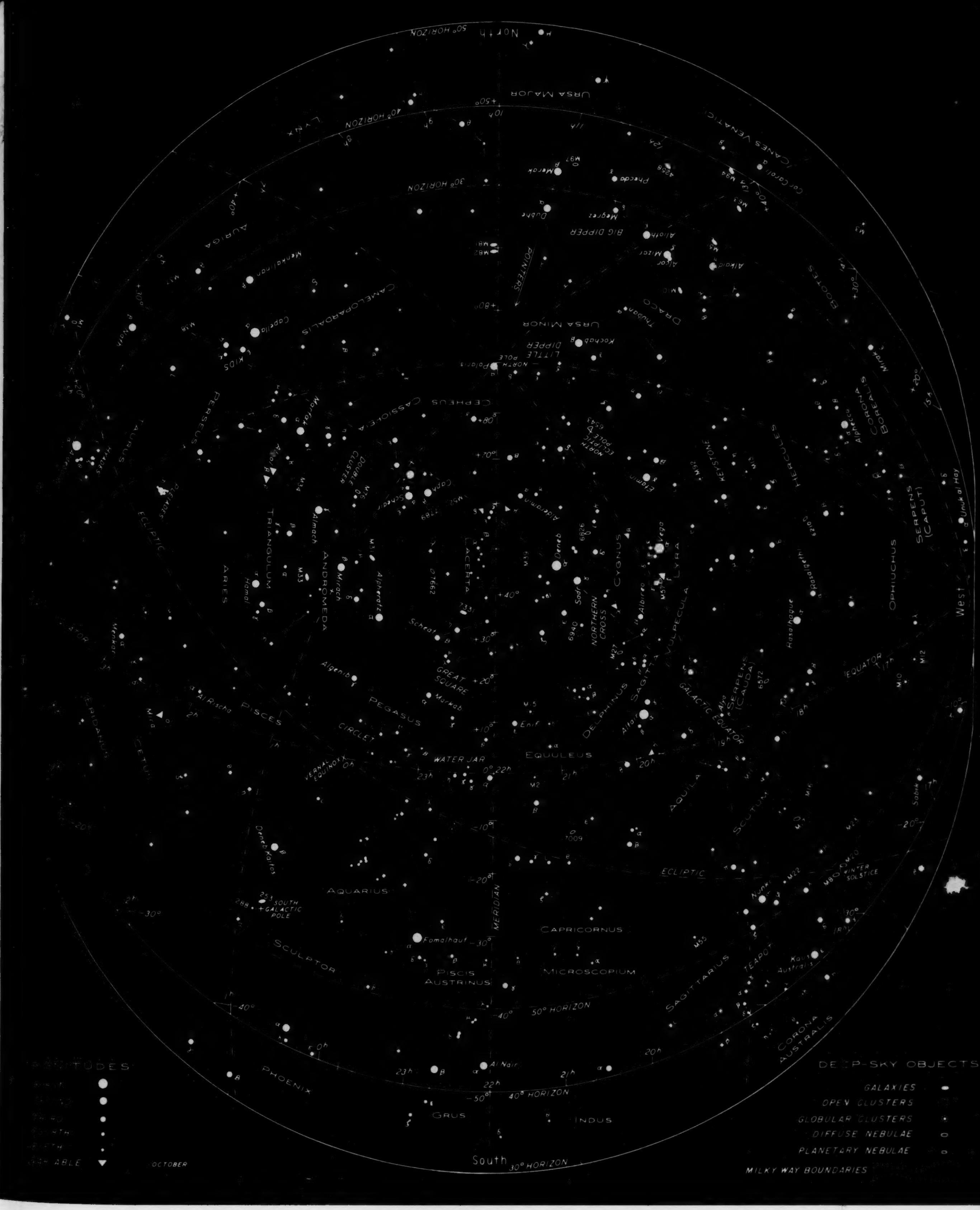
The sky as seen from latitudes 20° to 40° south, at 9 p.m. and 8 p.m., local time, on the 7th and 23rd of January, respectively.

SOUTHERN STARS

DURING January evenings the watcher of the southern skies will notice two extended patches of light, now situated above the south pole of the heavens. These patches, the Magellanic Clouds, resemble detached portions of the Milky Way, but they have no obvious connection with it. These distant stellar swarms are dwarf stellar systems in themselves. The most recent measurements of the distance of the Clouds puts them about 150,000 light-years from us, on the revised distance scale.

During the midsummer months two interesting variable stars can be located with the aid of this chart. Near the Large Magellanic Cloud is Beta in the constellation Dorado. This is a pulsating star, which varies in brightness from visual magnitude 4.1 to 5.0 and back in a 10-day period. This rhythm is repeated with great fidelity.

Another type of stellar variation is shown by L^2 Puppis, now in the eastern sky. This is a long-period variable, akin to Mira in the constellation Cetus. It requires 140 days to run its cycle of changes. In January it will be at maximum light, at about magnitude 4; during February it will fade, reaching minimum light early in March, at magnitude 5 or 6.



STARS FOR OCTOBER

The sky as seen from latitudes 30° to 50° north, at 9 p.m. and 8 p.m., local time, on the 7th and 23rd of October, respectively; also, at 7 p.m. and 6 p.m. on November 7th and 23rd. For other times, add or subtract ½ hour per week. When facing north, hold "North" at the bottom; turn the chart correspondingly for other directions. The projection (stereographic) shows celestial co-ordinates as circles.